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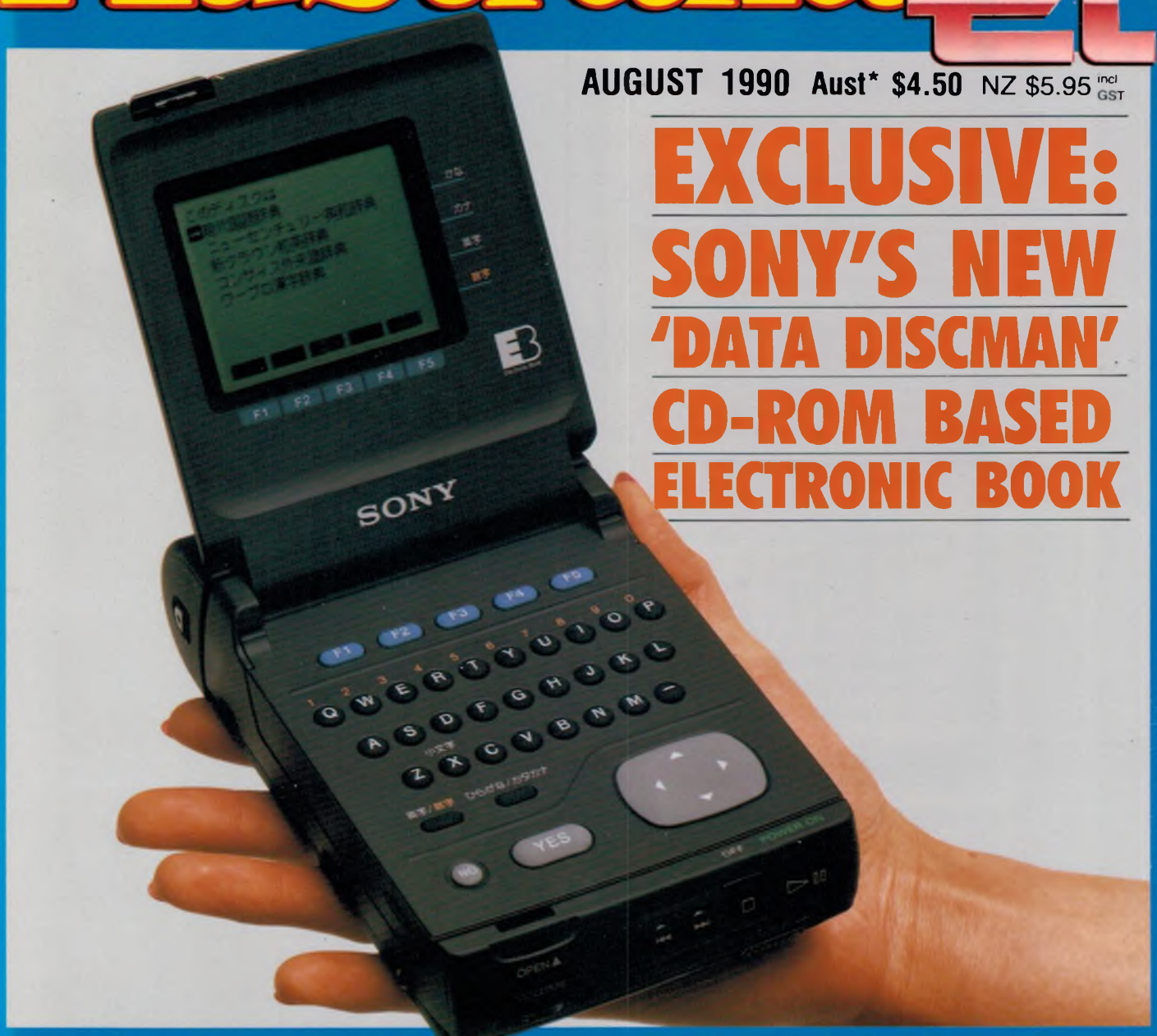

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PROJECTS TO BUILD: DIGITAL STOPWATCH/LAP TIMER, REPROGRAMMABLE LOCK, TTL/CMOS LOGIC PROBE

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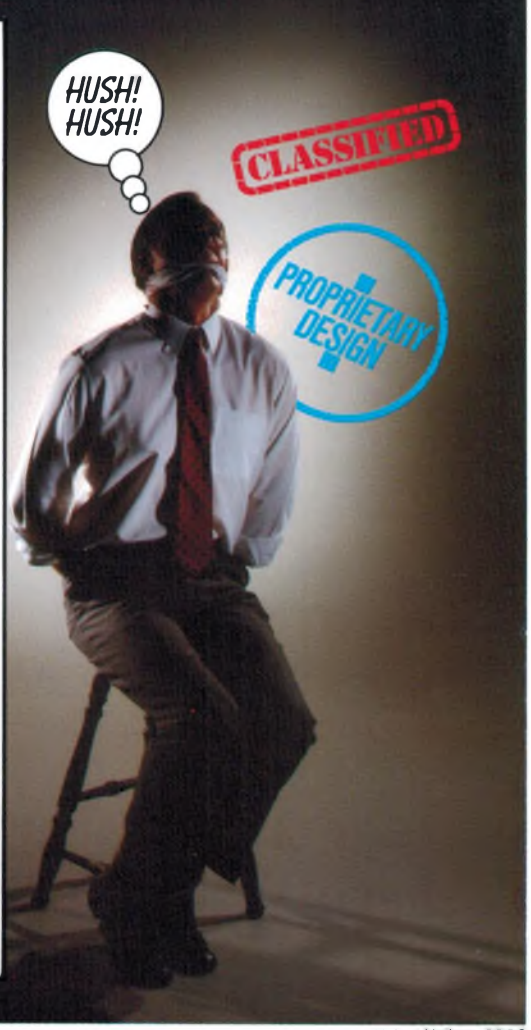

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August 1990

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Designing 7's new Telepools game

Next month the Seven network launches its new 'Telepools' game. Here's how its impressive computer-driven display system was created, explained by its designer. (Page 10)

This month's ETI is again in the centre of the book, starting opposite page 70. Highlights include a look at CD-ROM technology, by Geoff Bains; Louis Challis's report on KEF's new 'UNI-Q' speaker; Les Cardilini's look at Hitachi's laptop VCR; and a feature by Jim Rowe on current speaker technology.

On the cover

Sony's new 'Data Discman' handheld CD-ROM player has just been released in Japan, and should arrive here soon. It's basically the first true electronic book – see page 20. (Picture courtesy Sony Australia.)

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LETTERS TO THE EDITOR

Fluoro wiring

Along with Murphy's, Parkinson's and Peter's, I am developing a growing confidence in Weiley's law. That is, "Never check anything, you will find it's wrong."

In your otherwise informative article on page 162 of January 1990, 'Understanding Fluorescent Lamps', the illustration Fig.1, falls into the old trap of inserting the ballast in series with the supply *active* from the wall switch instead of the *neutral* conductor as illustrated by the manufacturer on the unit of the same page.

Over a period of some 40 years, I have pointed out this discrepancy to many qualified electricians, without lasting effect. I believe this is caused by a misguided idea that the limiting device should be in the supply active.

While I have never queried the manufacturers, I assume connection in the neutral is to reduce insulation stress and may also reduce radio interference. A few words from a manufacturer might clear up all our misconceptions.

W.B. Weiley, VK2AZW,
Boat Harbour, NSW.

Science and youth

The problem of a lack of bright young people going into science and electronics is indeed a worry, as you so wisely point out in your April editorial. The government must shoulder a lot of the blame and show more responsible leadership. The politicians are directly responsible for the exclusion of the far sighted, clear visionary Barry Jones, from the cabinet. This is a tragedy, whatever the colour of our political beliefs. Governments claim (mostly correctly) they only reflect community attitude, but they do have a responsibility to show more foresight and initiative on this issue.

What can we expect them to do?

Three suggestions:

1. A more positive attitude towards encouraging private enterprise (like the Sarich engine – now being developed overseas, or the airport radar system which met a similar fate);
2. Realistic funding of the CSIRO so it can function as it did years ago.
3. Provide science and technology education scholarships for the intellectually gifted. There is a lot of well meaning but misdirected funding for the slower learners in our schools. Quite a lot is known about the reasons for their lack of progress but little about what to do about it. The other end of the spectrum would respond much more positively to funding. Something is being done in this area, but it is not widespread. Many bright students are bored stiff with an unchallenging curriculum and at least, mark time for a few years. At worst they are completely turned off. This is a resource that Australia must nurture. Unfortunately, to spend public monies on bright students is likely to appear elitist and so be politically unpopular.

Item 3 above, is a hobby horse of mine, inspired by 30 plus years of (I think successful) mathematics teaching of 10 to 18 year olds. To give an uplift in student education, more funding is needed for good maths, science and technology teachers. The Federal Government has moved in this direction by provision of Higher Education Commonwealth Scholarships. These were, among other things, intended to provide scholarships to encourage teachers to switch from 'overcrowded' areas such as the Social Sciences, to Maths, etc., teaching. It sounds good, but has not happened in practice yet. Most HECS scholarships are going to provide higher degrees such as Master of Education. This is commendable in itself, although I cannot see how it helps the current teach shortage in Maths, etc. – nor, at the base line, whether many students will benefit.

Your magazine is doing its fair share of alerting the community. The problem is that you are preaching to the converted. It is up to all of us seriously interested and concerned about the situation to stir up a wider community interest.

For a start we should write to and stir our politicians. Passively sitting back and blaming 'them' will achieve nix. We must convince our representatives that there *are* votes as well as the future of our lovely country at stake.

Also we must somehow sensitise the whole community to the problem and try to shake off the lethargic 'Ocker/knocker' image that seems to exist about science and technology. The greenies have done it for conservation, so why cannot we achieve the same effect for technology? How about it, *EA* readers?

John Coulson,
Dilston, Tas.

Valve amplifier

I read with interest the article on the 'Series 500 Integrated Amp', (What's New in Home Electronics, May 1990), and I'm very happy to see that our forefathers are still gainfully employed!

I must admit the Tribrid critter does look 'simply stunning', but as far as the 'supersonic performance' – perhaps if a little shelf was added as a teapot warmer, you could enhance its spec's.

Enough of the sarcasm, I'm sure this unit will appeal to many groups. As ergonomics and compatibility play such a big role in marketing today, may I suggest an advert in a popular Amateur Radio magazine...

Finally, I would like to thank Audio Products for brightening up my dull day. It is great to see that some companies still have a sense of humour!

Graeme Barber,
Albury, NSW.

Shortwave listening

I am 13 years old and very interested in electronics and its applications, but especially in radio and communications.

I would be very happy if *EA* could start a new department which will include new stations received on the shortwave bands (broadcast and amateur), articles describing stations and their transmitting frequencies and even radio and communications projects (starting, perhaps, with an easy to build all-wave receiver which can resolve both AM and SSB).

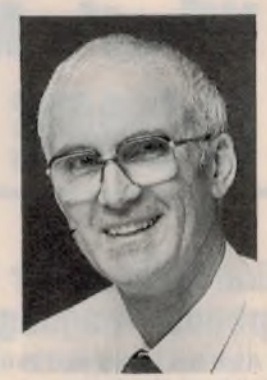
I think *Electronics Australia* is very interesting and informative, and it has helped me to learn most of what I know about electronics.

I'm quite sure that other readers will also be interested in the addition of this department to the magazine.

Ron Steinfeld,
Glen Waverley, Vic.

Comment: As you've probably noticed already, Ron, your wish has been granted. As part of the merger with ETI, we're again running Arthur Cushen's excellent column on shortwave listening. We hope you enjoy it.

EDITORIAL VIEWPOINT



Lessons to be learned from a developing country

A few weeks ago I had the opportunity to meet the chief executives of five leading electronics manufacturing firms from the Philippines, who were visiting Sydney as a Trade Mission organised by the Philippines' Department of Trade and Industry, and sponsored by the Australian Government through the ASEAN-Australia Economic Co-operation Program. Details of the five gentlemen concerned and the companies they run are given in this month's story, beginning on page 14.

It was very interesting to meet with these executives and to hear of the successful growth of both their own firms, and the Philippines' electronics manufacturing industry as a whole. Afterwards I also found it most informative to read through the literature they brought with them, describing the ways in which the Government of the Philippines has encouraged (and is still encouraging) the growth of electronics manufacturing – by both local entrepreneurs and foreign investors.

I couldn't help being struck by the contrasts between what has happened and is still happening in the Philippines, a country that is *developing* in both senses of the word, and in Australia – a country that has supposedly reached 'developed' status.

Through its 'Omnibus Investment Code', the Government of the Philippines has provided a wide range of incentives for investment in the country's manufacturing industry. These include income tax holidays, tax credits on the purchase of locally-manufactured capital equipment, tax and duty exemptions on capital equipment imported for manufacture, simplification of Customs procedures, and the creation of export manufacturing zones for fully foreign-owned bonded manufacturing.

The nett result of all of these incentives is that this 'developing' country now has a thriving electronics manufacturing industry, with annual exports averaging well over US$1 billion for the last eight years.

Contrast this with the situation here, where one way and another there has been very little real incentive for investment in local manufacturing – apart from the Australian Government's 'Partnerships for Development Program', which is essentially a tarted-up offsets scheme to force the multinationals to make at least a token investment in local manufacture. We have very few of the kind of incentives that are available in the Philippines, and no real commitment by our publicly-owned authorities to buy locally made products in preference to imports. In many cases our import duties on both capital equipment and components for manufacture are actually *higher* than those on complete imported products.

It's not surprising that our electronics manufacturing industry in particular seems much less bouyant than that of the Philippines. Non-PDP investment is very low indeed, and probably falling, while even with the figures for PDP firms included I suspect we're still likely to be trailing well behind them in terms of exports.

Sobering, isn't it, that our 'developing' neighbours are leaving us behind. It sounds as if *we* need to get stuck back into 'developing' again ourselves...

Jim Rowe

What's New In HOME ELECTRONICS

Akai VCRs offer many speeds, languages

Akai has introduced two further VCR models at the lower price entry points of $599 and $499: the VS-465 and VS-425 respectively.

Both models have picture quality, while the VS-465 offers the DX3 head system which AKAI claims to provide clear pictures even in slow, still, and frame by frame operation.

Up to 60 station pre-sets are provided, with the pre-tuning of stations 2, 7, 9 and 10. Further pre-set tuning or custom tuning to other desired frequencies is easily accomplished.

A total of 14 variable playback speeds are offered on the VS-465 and nine speeds on the VS-425. Akai uses its proprietary Interactive Monitor System on both models. This displays the programming information clearly on the screen, in bar-graph form. The programming instructions can be selected in any of eight languages – English, French, German, Spanish, Italian, Dutch, Swedish and Finnish.

Smallest VHS-C camcorder

Panasonic has launched the NV-S1, the smallest VHS-C camcorder weighing approximately 750grams and ergonomically designed to fit comfortably in the palm of a hand.

The NV-S1 movie camera is not only compact and easy to handle, but includes many innovative features – including EIS (electronic image stabiliser), which prevents picture jitter during shooting. EIS quickly detects and corrects displacement of the picture caused by unstable hand movement.

The camera's advanced auto focus system takes one second to judge which way the lens should move to catch action clearly and another for the movement of the lens. Focusing time has thus been shortened by a full second over conventional systems. If someone passes in front of the camera during shotting, the camera is able to quickly judge whether he or she is the new subject, or merely a passer-by who should not be focused.

Sound, although miniaturised is from an improved two-way unidirecitonal system improving sound quality and isolating annoying external noises often picked up by conventional microphones.

Useful functions provided on the NV-S1 including a still/strobe function, snapshot recording function, digital auto tracking and digital title memory.

The NV-S1 uses the popular VHS tape system in its compact 'C' type cartridge format, which can be played in any VHS video tape recorder.

The recommended retail price will be approximately $2500.

For further information contact Panasonic Australia, 95-99 Epping Road, North Ryde 2113 or phone (02) 886 0200.

New Sony power amplifier

To complement its recently released TA-E1000ESD digital signal preamp, Sony has also released a new power amplifier, the TA-N55ES.

The new TA-N55ES features high current delivery and high power output. FTC rates four ohm low impedance drive capability, spontaneous twin-drive supply design, G-chassis and discrete output devices ensure reliability and sound quality no matter what speaker is used.

As the cosmetic match to the new TA-E1000ESD, the TA-N55ES can be used in stereo and mono mode to power front channels and additional units can be used to power rear and centre channels, keeping a balanced configuration. It is priced at $899.

For further information contact Sony Australia, 33-39 Talavera Road, North Ryde 2113 or phone (02) 887 6666.

Breathing monitor for babies

'Life Alert' is an intelligent baby monitoring system that allows parents and babies to get a good worry-free night's sleep. Developed with leading paediatric researchers, it brings the high-tech safety of modern medical facilities into a simple easy to use home monitoring system.

At the heart of the system is a moisture proof mattress which is fitted with respiratory motion sensors and pulsation unit. The sensory mattress monitors the baby's breathing motion anywhere on the mattress surface. No awkward electrodes, wires or probes restrict the baby, which is completely isolated from all electrical components.

Using research carried out by the University of New England, dealing with the effects of pulsation in the treatment of asthma and other respiratory problems, the Life Alert Mattress has been designed to incorporate the option of providing physical breathing stimulus in the event of an emergency. These studies apparently have resulted in the conclusion that pulsations create an involuntary response in the muscles to initiate chest movement.

For further information contact Axiomedix, 72 Helen Street, Sefton 2162 or phone (02) 644 5822.

Audiophile D-to-A converter

Digilog from Musical Fidelity is claimed to be one of the first truly affordable stand-alone digital-to-analog converters aimed at the audiophile market, and is said to offer a new standard of digital replay fidelity.

Used with any CD player or DAT machine which has a digital output, the Digilog is said to upgrade performance to the highest level possible.

Digilog accepts two inputs of the coaxial line format and one in optic fibre format, and a digital output is also available for DAT monitoring. Extensive use has been made of new technologies in circuit design and layout and in the selection of components.

For further information, contact Audio Products, 8 Tengah Crescent, Mona Vale 2103 or phone (02) 997 4666.

Affordable VCR from Tandy

Tandy's model VR-2200 is a convenient and affordable VCR. Its special feature is the picture-in-picture display, where two programs can be watched simultaneously – one without sound – on an inset sub-screen. Program choice is made easier with multi-TV programme scan, where four still pictures are displayed at the one time, until the desired program is chosen.

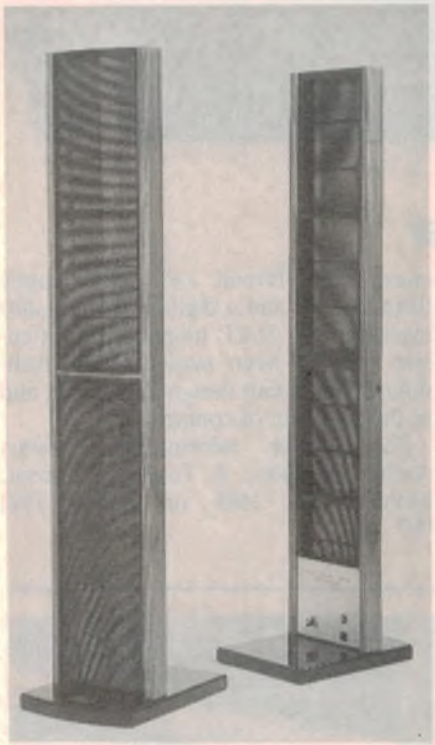
The VR-2200 includes the full range of normal VCR functions such as fast forward, reverse, record, pause etc. An infra-red multifunctional remote-control has LCD display with clock, date and on-screen prompts.

Suitable for instruction videos, the Lesson Repeat function allows a section of tape to be repeated up to five times. The Index/Go To Search function records an ID number at the beginning of each program and searches for it when required.

With the Quick Start Recording timer you can quickly start recording a program and then set its finish time, so there's no problem with missing the start of a show. A built-in one year, six-event timer means you can record easily when not home.

The VR-2200 is priced at $1199.

For further information contact your nearest Tandy store or phone (02) 675 1222.



Locally made electrostatic loudspeaker

The Australian-made TSP2400 has an electrostatic cell with walnut emperite side panels 2100 x 415 x 100mm deep. It has the power supply built into the base of the cell, running at 4kV using a mains isolating transformer and voltage amplifier network. The minimum audio drive power required is 20W, with a maximum of 250W.

The speaker membrane is made of high tech plastic film using metal alloy formula coating. This is a departure from conventional electrostatic technology, preventing migration of the conductive coating. It has frequency response from 35Hz to 22kHz in a normal lounge room environment. As there is no enclosure as such, the low end response is determined by the dimensions of the listening room and its acoustics.

The TSP2400 has a horizontal dispersion of 35° to give a wide angle of image, and in the vertical direction it is a line source. Rear radiation is equal to front radiation, giving a realistic ambience.

The quoted price for the TSP2400 system is $12,000. For further information contact TSP Technology, 4/11 Clarice Road, Box Hill 3128 or phone (03) 899 6755.

Twin compact disc and cassette system

Sharp's ZCD830 is a portable hifi system which features twin compact disc players and a twin cassette system. Now you can program the tracks on two of your favourite CDs to play without interruption for up to two hours, in whatever order you decide.

Designed as a portable shelf hifi, it is powered by batteries and normal household electricity supply, allowing it to be played both indoors and outdoors. Two 12cm free edge woofers and an 8cm super woofer are built in, with optional twin 8cm full range surround speakers also available.

The ZCD830's twin CD players have an automatic programmable music selector (APMS), plus an automatic program locate device (APLD) and automatic program search system (APSS) enabling you to nominate your own selection of tracks to play in the order you prefer, or immediately access any tracks of your choice. You can operate APMS, APLD and APSS for both CDs via the remote control.

Other features of the unit include X-bass boost, a four-band graphic equaliser and four-band spectrum analyser, and volume indicator. The ZCD830 has a recommended retail price of less than $1100.

For further information contact Sharp Corporation of Australia, 1 Huntingwood Driver, Blacktown 2148 or phone (02) 831 9350.

Super-VHS time lapse recorder

Almost three weeks of high resolution, time lapse recording is now possible using Panasonic's new AG-6720 S-VHS/VHS time-lapse video cassette recorder.

This versatile VCR, distributed locally by GEC Video Systems, records up to 480 hours of time lapse images and is ideal as the core of a CCTV surveillance system for observation and task or process analysis. The robust mechanical construction of the AG-6720 and the professional picture quality of the Super-VHS format provides excellent time-lapse images without flashes, glitches or picture instability.

For trigger recording, a simple rear-panel connection accepts a contact closure-type trigger, to enable VCR activation from an alarm circuit command. Very long time lapse recording projects can also be easily controlled via the internal or an external timer.

Horizontal resolution of more than 400 lines in both colour and black-and-white is a feature of the S-VHS format. S-VHS also involves the use of a higher frequency FM radio signal compared to conventional VHS, to produce extremely sharp, low noise pictures.

For further information contact GEC Video Systems Division, 2 Giffnock Avenue, North Ryde 2113 or phone (02) 887 6222.

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For example, when a movie shows a gun being fired, you'll hear the bullet ricochet around the room. When a plane prepares to land, you'll hear it soar over you from behind and touchdown at the front of the room - that's just how life-like this system sounds! All functions are fully managed by a learning remote control which completely integrates and operates your TV, video and audio system.

To experience the excitement of 'MOVING SOUND' and to find out just how easy this system is to operate and install in your living room, see your local YAMAHA HI-FI Specialist now.

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FIVE YEAR WARRANTY

*Dolby Pro Logic Surround is a trademark of Dolby Laboratories

READER INFO No. 2

The Telepools game in operation at Channel 7's studios, with compere Jimmy Hannan. As you can see, the set is built to look like a large Pools coupon, and is quite impressive.

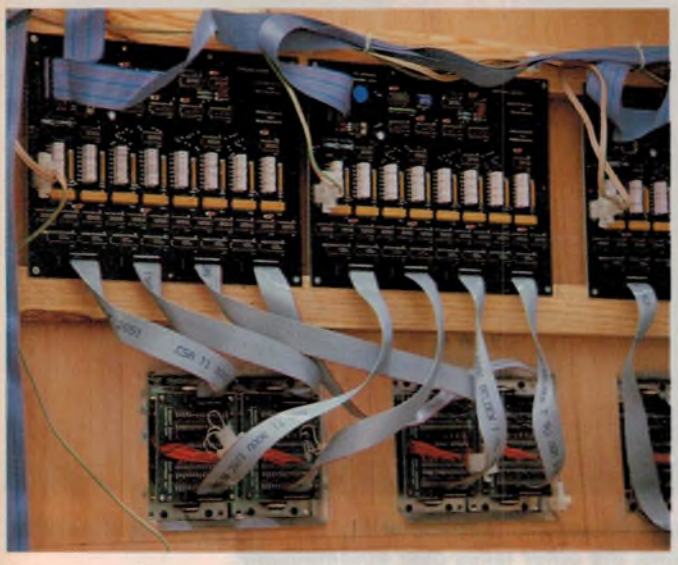
Inside 7's new 'Telepools' TV game

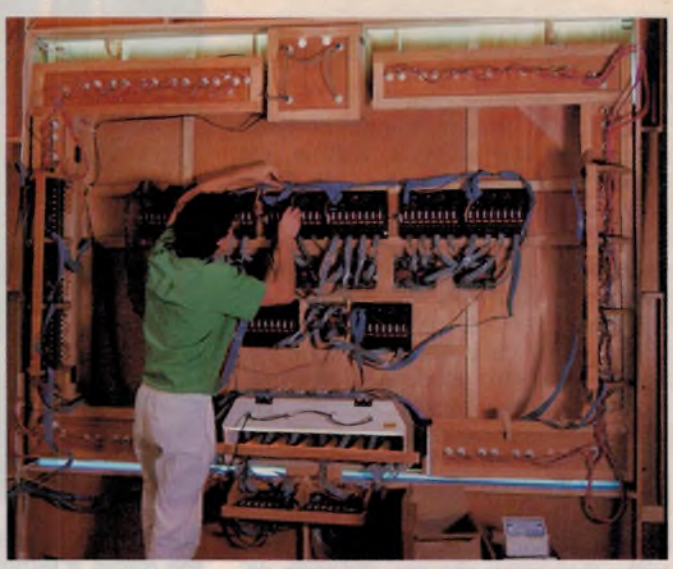
Next month, a new gameshow should be going to air on the Seven TV network across Australia. 'Telepools' is a fast-moving 3 minute segment which gives players of the Australian Soccer Pools a second chance to win prizes and cash. Although the game appears simple, a lot of technology has gone into the studio set you see on your TV. The electronic system was designed and built by Right Hemisphere, a design company located in the Blue Mountains west of Sydney. In this article, Right Hemisphere's MD Peter Vogel describes the special problems that this project presented and how they were overcome.

The Telepools game is the brainchild of Barry Newman, Creative Director of Kevin Jacobsen Marketing. The objective was to provide a TV gameshow linked to the well-known 'Pools'; an Australia-wide 'soft gambling' game which until now, has not had a very high television profile. Telepools allows Pools players who were not lucky enough to pick the winning numbers a second chance to win prizes and cash. The basic idea is that a contestant plays from their home via the telephone. The show is hosted by Jimmy Hannan.

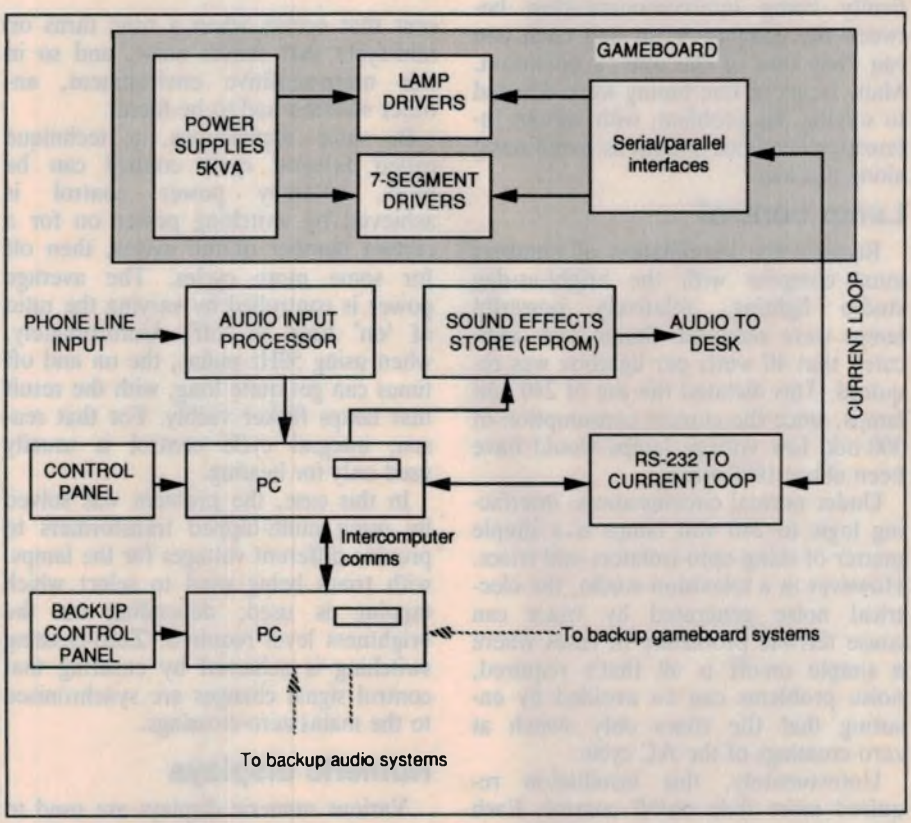
Behind Jimmy is a huge board laid out like a Pools coupon, with the numbers 1-38 in a larger-than-life array. Several times per second one of these numbers is illuminated, the sequence being random. To play the game, the player nominates six numbers, from one to thirty-eight. He or she then says the word 'pools' into their phone, which causes the number illuminated at that moment to be 'locked off'. If that number is one of the nominated numbers, the corresponding prize is theirs. This is repeated six times, so there is a good chance of winning something. To make the rewards greater still, each time the player locks off a number, a cash prize is given as well.

The whole game is over in just three





Above shows the rear of the electro-mechanical displays, each driven by dual controller cards (one for backup). Above right shows Peter Vogel installing one of the 100-odd cards, while at right is the overall system block diagram.



minutes, in which time that week's official Pools game results are revealed and the home player can win up to six prizes plus cash.

The mission

It took a number of years for the Telepools concept to become a commercial reality, but once contracts had been signed, things moved quickly. Because of the need to construct the studio set before a pilot programme could be recorded, there was considerable urgency to get the system operational as quickly as possible.

Right Hemisphere was briefed early in 1990, and a timeframe of just eight weeks was nominated for design and construction of the electronics required. Meanwhile, a set construction company, Telsets, was commissioned to produce the physical set into which the electronics would be installed.

Basic strategy

Although the game is fairly straightforward to play, the control system required is far from trivial. The gameboard contains over 300 lamps, as well as some 30 seven-segment displays, each requiring individual computer control. The game also requires audio from the telephone line to be processed and used as a trigger, and a number of different sound effects to be generated as the game progresses. A complex graphics display was also required, to mimic the action of the gameboard so that the operator can check that all is operating properly.

The basic strategy adopted was to use a personal computer with VGA graphics, connected to specialised interfaces for controlling the lamps, displays, and audio input/output circuitry.

The gameboard is located at some distance from the computer, so in the interests of eliminating the risk of earth loops and noise problems, an optically-isolated serial current loop was chosen as the best means of interconnection. This was also a wise safety measure, since the computer needed to be interfaced to many kilowatts' worth of 240 volt lamps.

Failsafe system

The prime requirement for the system was that it be highly reliable and failsafe. Because the game is played with a home contestant 'on line', there is no scope for going back and re-taking in case of equipment failure – a player would not be very happy to be told, "Sorry, you didn't really win that car, it was a computer fault". The design had to ensure that no matter what compo-

nent fails, the show goes on.

To achieve this, a strategy of 100% redundancy was adopted; that is, the entire system is duplicated and both run in tandem. In case of a failure, ranging from a blown lightbulb to a computer crash, there is always a backup system on-line, ready to take over. As a result, there are two of everything – two lamps behind each illuminated number, two sets of control electronics, two computers, and two power circuits. The only things that could not be duplicated were the electromechanical seven-segment displays; more about these later.

Computer systems operating in tandem or backup mode are a little more tricky than meets the eye; the main difficulty being intercommunication between the computers, so that each one can keep tabs of the other's operation. Many hours of fine-tuning were devoted to solving this problem, with various interesting deadlock situations manifesting along the way.

Lamp control

Because the illumination of numbers must compete with the bright-as-day studio lighting, relatively powerful lamps were required. Studio tests indicated that 40 watts per lightbox was required. This dictated the use of 240 volt lamps, since the current consumption of 300-odd low voltage lamps would have been about 1000 amps!

Under normal circumstances, interfacing logic to 240 volt lamps is a simple matter of using opto-isolators and triacs. However in a television studio, the electrical noise generated by triacs can cause terrible problems. In cases where a simple on/off is all that's required, noise problems can be avoided by ensuring that the triacs only switch at zero-crossings of the AC cycle.

Unfortunately, this installation required more than on/off control. Each lamp has three possible brightness levels. Because most lamp failures occur when first switched on from cold, a 'warmup' level is applied to keep the filaments warm when the lamp is otherwise off. The next level is a visible 'on', and the highest level is used for 'highlight'.

The usual means of dimming lamps is to use phase control, whereby a triac is fired at some point into the cycle on each cycle. By changing the delay between the zero crossing and the firing of the triac, the amount of power delivered to the lamp can be smoothly controlled. It's the sudden rush of current that occurs when a triac turns on mid-cycle that causes noise, and so in this noise-sensitive environment, another solution had to be found.

This studio action shot shows the screens of the two computers that control the game. If either fails, the other takes over automatically.

In some applications, a technique called *integral cycle control* can be used, whereby power control is achieved by switching power on for a certain number of full cycles, then off for some more cycles. The average power is controlled by varying the ratio of 'on' time to 'off'. Unfortunately, when using 50Hz mains, the on and off times can get quite long, with the result that lamps flicker visibly. For that reason, integral cycle control is usually used only for heating.

In this case, the problem was solved by using multi-tapped transformers to provide different voltages for the lamps, with triacs being used to select which tapping is used, depending on the brightness level required. Zero-crossing switching is achieved by ensuring that control signal changes are synchronised to the mains zero-crossings.

Numeric displays

Various numeric displays are used to show the player's numbers, the Pools results, and cash values. The obvious choice was seven-segment LED displays, which are now available in the 100mm-high units called for in this application. Unfortunately, things were not to be so simple, as the studio lighting proved too much for the yellow LED displays tested.

The so-called 'superbright' red LEDs were much more visible under the bright lights, but unfortunately TV cameras respond very badly to red light – resulting in very blurry images.

Much leafing through catalogs eventually turned up the ideal solution: seven-segment electromechanical displays. These units comprise seven segments in the form of plastic vanes, which are painted yellow on one face and black on the other. A small solenoid on each vane is used to flip it over, to show either yellow or black as appropriate.

The advantage of these displays in this application is that they rely on reflected light, rather than emitted light, so that the brightness and contrast increases as the ambient light increases.

The difficulty, from Right Hemisphere's point of view, was that these devices are not as easy to interface and control as conventional seven-segment LEDs, requiring relatively large current pulses to flip the vanes. As with the lamp controllers, there was nothing available off-the-shelf, and suitable interfaces had to be designed, tested, and built in short order.

Another unusual problem concerning the numeric displays was that of the dual redundancy of the system. As mentioned previously, the whole Telepools system has been designed as two independent systems working together to provide a backup in case of component failure or some other breakdown. Whereas each illuminated number on the board could contain two lightbulbs without looking strange, it was obviously not possible to provide two identical sets of numeric displays.

Fortunately, the displays themselves are inherently quite robust, and not likely to fail except from physical abuse. This type of display also has the fortunate characteristic of inherent memory, which is another term for mechanical latching; once set to show a particular digit, the display stays in that state even if the power is turned off.

The most likely causes of breakdown

of the numeric displays is failure of one of the solenoid drivers or a power supply, or a dodgy interconnecting cable. To ensure continuity of operation in any of these events, a rather unusual 'dual port' arrangement was devised for the displays. Each display has been fitted with a circuit board with diode logic, to allow two independent control cables to feed the one set of solenoids independently. This ensures that the only common point is the display device itself, so that in the event of failure of any of the electronics, the redundant (backup) circuitry can take control.

Voice control

The main attraction of the Telepools game is that a player participates via phone from home. This is achieved by feeding the player's voice into a specially developed interface, which causes a random selection to be made when they say the word 'Pools' into the phone.

To achieve this, more custom circuitry had to be designed.

To detect the word 'pools' in particular, while rejecting all other words, would present a significant problem. However, this is not really necessary for the Telepools game; the only requirement being that when the player speaks, it is reliably detected, and that the system be immune to noise and other vagaries of the phone system.

Much experimentation was required to determine the best way of achieving this. The detection system is based on recognising the envelope function of the trigger word 'Pools'.

For these experiments, a peak detector with a time constant of a few milliseconds was hooked up to a phone and the resulting envelope watched on an oscilloscope. By saying 'Pools' hundreds of times in different ways, an average picture of the envelope shape was arrived at. Having determined the limits of the rise and fall times expected, circuitry was designed to detect envelopes within those limits.

To accommodate the wide variation in signal levels to be expected from a phone line, a long-timeconstant AGC circuit was added at the front end. A bandpass filter, to remove hum and noise outside speech bandwidth, completes the detector.

The result is a very reliable 'Pools' detector, immune to the pops, clicks, hums and buzzes which occur unpredictably on the line.

Sound effects

As the game progresses, a number of different sound effects are produced, under control of the computer. These sounds are used to indicate prize wins and other special occurrences.

Various ways of outputting sounds under computer control were considered. Generating the sounds using software was ruled out, as that would limit the range of sounds to electronic-sounding beeps of various types. To achieve total flexibility of sounds, a 'sampled sound' technique was required.

Although it would be possible to store the sounds in digitised form on disk, then load them into RAM and play them out through a DAC on a parallel port, this would have occupied too much RAM and chewed up a lot of processor bus bandwidth.

The task was offloaded onto a peripheral device, designed especially for the job. A separate box was designed containing digitised sounds stored in 1 megabit EPROMs. To play a sound, the main computer simply writes a control byte to a parallel port, and from there on the external hardware takes care of clocking the data out of the EPROMs and turning it into audio.

Software

The software required to make all this equipment do what you see on TV is no trivial piece of code, requiring many things to operate simultaneously. For example, when the game is in its 'idle' mode (waiting to play with just lights flashing), about 300 lamps are being individually turned on and off at the right times. This involves a large volume of data being sent across the serial links to the gameboard, and a fair amount of computing to make the lamps execute the required patterns.

Once the game is under way, each of the seven-segment displays' segments must do the right thing at the right time, and while that's happening sound effects are being produced and the phone input monitored. All in all, the 20MHz AT computer does not have a lot of spare time!

The Lotteries Office has scrutinised the project at every stage to ensure the game is absolutely fair, especially in the area of 'random' selections. The usual way of achieving so-called 'randomness' in computers is to use a pseudo-random number sequence. This was not considered random enough for this game, and alternative techniques had to be developed.

For reasons of security, the details of this must remain a secret. Be assured, however, that there is no line of program even remotely resembling 'IF PLAYERNAME = VOGEL THEN PRIZE = $1000000'!

PHILIPPINE TRADE MI

Executives from five leading electronics manufacturing firms in the Philippines visited Sydney recently, to meet their counterparts in the local industry. The aim was twofold: to expand the markets for their products, as well as to promote the benefits to Australian firms of using their facilities and human resources for cost effective off-shore manufacturing.

by JIM ROWE

The clock display assembly area at Pricon Microelectronics, in Taguig, Metro Manilla. Currently PMI's plant is of 80,000 square feet.

The Philippines has been active in electronics manufacturing for many years, although until relatively recently most of the firms were essentially performing off-shore assembly for companies in the USA, Japan or Europe – either as subsidiaries or contractors. This is witnessed by the 'Assembled in the Philippines' legend on many of the IC's and other components marketed by large multinational firms such as Intel, National Semiconductor, Fairchild, Motorola, Philips Components, Texas Instruments, Telefunken, AMD, Zilog and Analog Devices.

But more recently, as the industry and its managers have gained experience, many of the Philippines' original contracting assembly firms have established themselves as autonomous manufacturers – developing their own products and export markets. Newly established firms have joined them, often set up by keen and entrepreneural young engineers.

The Philippines' Government has also been working to encourage further investment in electronics manufacturing, by both domestic firms and domestic-foreign joint ventures. It provides a variety of incentives including tax holidays, duty exemptions for imported capital plant, tax credits on locally sourced capital plant, exemptions from export taxes and duties, and so on. Three special 'export processing zones' have also been established, in Mactan, Baguio and Bataan, to encourage fully foreign-owned firms wishing to set up export-only manufacturing plants.

Special Customs arrangements have also been established for the semiconductor industry, which is accorded 'vital industry' status. Semiconductor assemblers and manufacturers are exempted from pre-delivery Customs inspection, in recognition of the fast pace of the industry and the short cycle times required to maintain competitiveness.

The nett result is that today, the Philippines' electronics manufacturing industry is in a very healthy state, and growing rapidly. So much so that some observers have predicted that the country is shaping up as the next international focus for electronics manufacturing, following hard on the heels of Taiwan and Korea. And as part of its growth strategy, the industry is sending trade missions to many different countries – especially in the Pacific region – to promote both its products and its resources.

The recent Electronics Trade Mission to Sydney was organised as part of the Trade and Investment Promotion Program (TIPP), sponsored by the ASEAN-Australian Economic Co-operation Program (AAECP) to boost trade for Philippine electronics and electrical manufacturing and products. The actual organisation of the mission was carried out by the Philipines' Center for International Trade Expositions and Missions (CITEM).

The five executives who made up the mission were Mr Lawrence Qua, President of Complex Electronics Corporation; Mr Julius Labrador, President of Labtech Manufacturing Industries and Labrador Electronics Corporation; Mr

SSION VISITS SYDNEY

Alfredo Pacho, President of Pricon Microelectronics Inc; Mr Hilary de Leon, General Manager of Mitech Corporation; and Mr Abel Balleras Jr, General Manager of Beltron Computer Philippines, Inc. Also accompanying the executives was CITEM representative Mr Vicente Uy.

Complex Electronics Corporation is based in Makati, Metro Manilla, and is in fact the oldest electronics subcontractor in the Philippines. It has been a pioneer in surface mount technology, and produces electronics subassemblies for fax machines, hard and floppy disk drives, remote controls, radar detectors, VCRs, optoelectronic displays and so on. It also produces a wide range of components, including opto couplers, switches, bridge rectifiers and coils. Complex forms part of a trio of companies, the other two members being Ionics Circuits and Onyx Inc. Ionics specialises in hi-rel and advanced packaging, while Onyx provides the group with technology support and marketing in the USA.

Labtech Manufacturing Industries and **Labrador Electronics Corporation** are both based in Cubao, Quezon City. Labrador Electronics was founded by Mr Julius Labrador in the 1960's, as a contract manufacturer of TV and radio receivers. In the 1970's it shifted to the industrial electronics area, producing a range of automatic voltage regulators (AVR's) and uninterruptible power supplies (UPS's). These have been marketed very successfully in the Philippines under the 'Wilson' and 'Powerlab' brandnames, with annual sales currently around 20 million pesos mark (there are approximately 20 pesos to the US dollar).

Testing automatic AC voltage regulators at Labrador Electronics Corporation, in Cubao, Quezon City. LEC also makes a range of uninterruptible supplies.

Labtech was also founded by Julius Labrador, in 1976, as a semiconductor manufacturing subcontractor to Shindengen Electric Manufacturing of Japan. For some time it was the only manufacturer of bridge rectifiers in the ASEAN region. Today it employs over 600 people, and produces over 140 million semiconductor products per year – including bridge rectifiers, transistors and transistor arrays. Annual sales exceed 200 million pesos.

Pricon Microelectronics Inc. is based in Taguig, Metro Manilla. Founded in 1985, it initally specialised in the manufacture of magnetic recording heads. Since then it has expanded to perform contract assembly of cordless telephones, scanning receivers (both handheld and desktop) and clock LED assemblies, as well as general assembly of PCB modules. PMI's plant is currently 80,000 square feet, and includes a Class 10,000 production assembly area and a clean room.

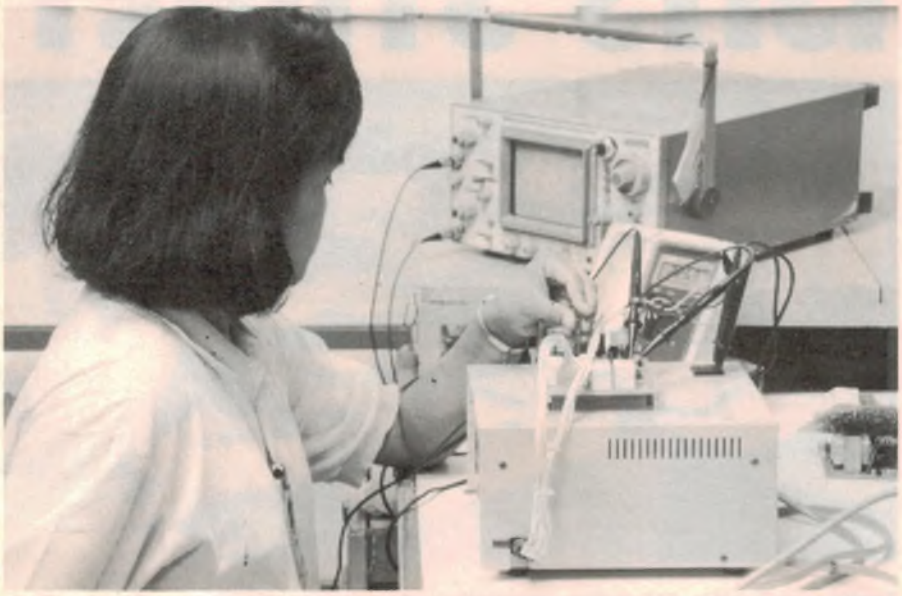
Mitech Corporation, based in Makati, Metro Manilla, specialises in the design and manufacture of innovative microprocessor-based equipment. The firm's products include handheld and desktop personal computers, an intelligent telex interface for PC's, modems, air conditioning and security controllers, data logging/process control systems and barcode reading systems. Mitech's latest product is Logbox, an employee timekeeping and payroll system using magnetic cards, designed to replace bundy clocks and timecards.

Beltron Computer Philippines, Inc. is a leading manufacturer of micro and personal computers, based in Malabon, Metro Manilla. It currently produces around 3500 machines per month, of which 10% is exported to the USA.

The selection of the firms represented in the Mission was made on the basis of recommendations made by Tim Gee, a Senior Consultant at Imras Consulting – a Sydney firm which specialises in in-

Left: PMI's assembly line for cordless telephones. Above: Final assembly of uninterruptible PS's at Labrador Electronics.

Philippines Trade Mission visit



A testing station for semiconductor devices, at the Labtech Manufacturing Industries plant in Cubao, Quezon City.

ternational market research analysis and strategy. Mr Gee visited many factories in the Philippines, and prepared a report for the Philippines' Consulate. Each of the firms selected has export experience, and has demonstrated its committment to servicing customers in different parts of the world.

The Philippines has a population of around 57 million, with a high level of education. Current annual enrolment in universities and tertiary colleges is 30,000, while over 150,000 are enrolled in technical and vocational schools. Around 20% of all university and college graduates are in engineering – a particularly high percentage.

English is the most widely spoken foreign language, and the Philippines is in fact regarded as the third largest English-speaking country in the world.

In terms of electronics manufacturing, the Philippines can offer labour costs around 10-20 times lower than in developed countries, coupled with the ability to provide fast turnaround and delivery. At the same time the high educational standard and level of familiarity with English, among its workforce, are factors giving the Philippines a strong potential advantage over other developing Asian countries.

"The Philippines has a great potential in the Australian market, because of the low labour costs", emphasises consultant Tim Gee.

From my brief meeting with the members of the recent Trade Mission, I gained the distinct impression that the Philippines' manufacturers are not only keen to exploit this potential, but well qualified to do so.

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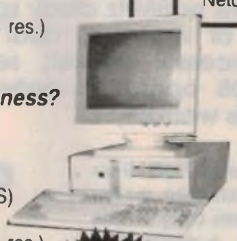

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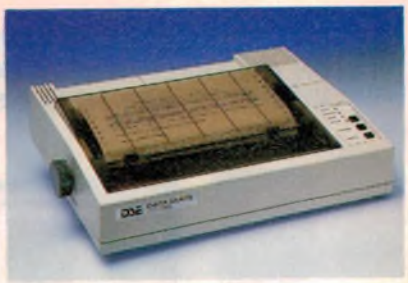

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1. The competition is open only to Australian residents authorising a new/renewal subscription before last mail 28.09.90. Entries received after closing date will not be included. Employees of the Federal Publishing Company Pty Ltd and Dick Smith Electronics and their families are not eligible to enter. To be valid for drawing, the subscription must be signed against a nominated valid credit card or if paid by cheque, cleared for payment.

2. South Australian residents need not purchase a magazine to enter, but may enter only once by submitting their name, address and a hand-drawn facsimile of the subscription coupon to Federal Publishing Company Pty Ltd, P.O. Box 227, Waterloo NSW 2017.

3. Prizes are not transferrable or exchangeable and may not be converted to cash.

4. The judges decision is final and no correspondence will be entered into.

5. Description of the competition and instructions on how to enter form a part of the competition conditions.

6. The competition commences on 25.06.90 and closes with last mail on 28.09.90. The draw will take place in Sydney on 03.10.90 and the winners will be notified by telephone and letter. The winners will also be announced in *The Australian* on 06.10.90 and a later issue of *Electronics Australia*.

7. The prizes are: Three Acer 500+ computer systems – each valued at $1995 – total value $5985.00.

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NEWS HIGHLIGHTS

SONY LAUNCHES 'DATA DISCMAN' - CD-ROM BOOK

In a move that may well mark the beginning of a new era in data retrieval, Sony Corporation has launched a new CD-ROM based 'Data Discman' or DD-1, on the Japanese market. The unit takes 80mm CD-ROM disks, and at the touch of a button displays the stored data on a built-in LCD screen.

Measuring only 160 x 108 x 42mm and with a weight of only 550 grams, the DD1 is easily handheld. In this it carries on the tradition of Sony's previous audio cassette 'Walkman' of 1979, its audio CD 'Discman' of 1984 and the 'Video Walkman' released only 18 months ago.

In this case the unit is functionally equivalent to current CD-ROM based retrieval systems using a personal computer linked to a CD-ROM drive, and running suitable data retrievel software. However as well as being very much smaller and easier to drive, the DD-1 is also much less expensive: in Japan it sells for only 58,000 yen – approximately $580. This includes a sample CD-ROM disc storing English/Japanese, Japanese/English and three Sanseido Japanese language dictionaries.

The DD-1 has a keyboard based on the Roman alphabet, and allowing for several methods of data retrieval: word search, keyword search, menu search, multi search or consultation search. All necessary retrieval software is built into an internal ROM. The swing-out monochrome LCD screen has a resolution of 256 x 200 pixels displays 10 lines of 15 characters, scrolling as required to read the retrieved text.

Other features of the DD-1 include a built-in video adaptor for displaying the retrieved data on a TV screen, and the ability to play normal 80mm audio CD 'singles' via headphones. The unit comes with both an AC power adaptor and a rechargeable battery pack, but will also run from a car battery via an adaptor cable.

Sony says that a range of database CD-ROMs are being produced by other publishers, to suit the DD-1. These include textbooks, travel guides, dictionaries, instruction manuals and so on. At least 18 titles were expected to be released on July 1. It certainly looks as if the 'Data Discman' may well become the first true 'electronic book'.

NEW HYDROGEN MASER FREQUENCY STANDARD

Anritsu in Japan has developed a new hydrogen maser frequency standard.

The unit is a super-precise frequency standard, generating a microwave signal which is produced by the stimulated emission of electromagnetic waves during hydrogen atom state transistions. The hydrogen maser has the best frequency stability of all available frequency standards, being in the order of 10^{-15}.

Because of this excellent frequency stability, the hydrogen maser frequency standard is suitable for use in advanced scientific measurement fields. These include terrestrial very long base line interferometers (VLBIs), space VLBIs and navigational tracking systems for space exploration.

HP & OKI TO BUILD PCB PLANT IN PEURTO RICO

Hewlett-Packard of the USA and Oki Electric Industry of Japan have announced an agreement to build and jointly operate a printed-circuit-board manufacturing facility in Puerto Rico. The joint venture has begun securing construction and operating permits from the Puerto Rican government.

Together, the companies will invest $40 million to construct a 115,000-square-foot plant at HP's site in Aguadilla. HP's Peurto Rico operation will use the boards in its computer products. Oki's portion of the jointly manufactured PC boards will be sold on the open market.

Construction is expected to be completed in 1991. The plant ultimately is expected to employ 200 people.

VERY LOW CURRENT SEMICONDUCTOR LASER

Researchers at the University of California at Santa Barbara claim to have produced the first surface-emitting semiconductor laser to operate at a current level of around 1 milliamp – at least 30-40% the current level of any previous device.

The new team, led by Professor Larry A. Coldren, has produced the first devices to have a threshold current density of less than 1000 amps per square centimetre. This level is regarded by researchers as the maximum allowable for practical development of photonic ICs, which will use light signals for switching and signal processing as an alternative to electronics.

The new UCSB chips operate at a density of only 600 amps per square cm.

TI, KOBE TO MAKE CMOS CHIPS

Texas Instruments and Kobe Steel have jointly announced an agreement to establish a joint-venture company, to manufacture advanced semiconductors in Japan. The venture will manufacture primarily complementary metal oxide semiconductor (CMOS) logic devices, including very large scale integrated (VLSI) circuits and application-specific integrated circuits (ASICs).

Semiconductor products manufactured by the joint venture will be sold exclusively to Ti for distribution and sale by Ti to customers in Japan, throughout the Asia-Pacific region, and in other world markets.

Design work on the wafer-fabrication facility for the joint venture will begin promptly, with construction in Hyogo Precture in the Kansai region of Japan to start in early 1991 and be completed by the end of 1991. Full-scale production is expected by mid-year 1992 based on advanced submicron CMOS technology.

Total investment in the initial wafer fab is estimated at about US$350 million, including land, building and equipment.

SIEMENS & IBM TO BUILD 64Mb DRAMS

Siemens of West Germany and International Business Machines Corporation of Armonk, NY (USA), have signed an agreement to jointly develop 64-million-bit memory chips. The agreement also provides for discussion of further cooperation on subsequent semiconductor memory generations.

Joint development of the 64-million-bit DRAM will begin immediately at Siemens and IBM. The common activities will be concentrated at IBM's new advanced Semiconductor Technology Centre in East Fishkill, New York and use the resources of both the Munich facility of Siemens and the Essex Junction/Vermont facility of IBM. Production of the chips will take place in manufacturing facilities of the respective companies.

Each company will share equally in the development costs.

The goal of the project is to have a world standard 64-million-bit DRAM ready for commercial introduction in the mid-1990's. Work will concentrate on the chip design and the process technology, using the most sophisticated tools and materials available.

NEC RELEASES 'NEXT GENERATION' PORTABLE PHONE

NEC Australia has released the 'revolutionary' P3 portable 'phone – its smallest and lightest ever mobile communications device. Weighing a mere 400 grams, with dimensions of only 172 x 55 x 24mm, the P3 represents the beginnning of what a senior Japanese executive has dubbed the 'Personal Communications Era'.

The P3 is, at last, a truly 'mobile and portable' phone that lives up to its description. Weighing around half as much as most of its competitors, it can easily be slipped into a pocket without discomfort.

There is no need to remember 'phone numbers with the P3. It features an easy-to-read 30 character alphanumeric display, with instant search of 99 stored names and numbers. Its long-life compact battery can be switched to 'stand by' mode, thus enabling the P3 to await calls for 18 hours and provide 80 minutes of continuous conversation.

NEC's new P3 portable phone.

The P3 was officially released in Australia by Mr Tomiaki Mizukami, General Manager of NEC Corporation's mobile media terminals division.

DIGITAL OPENS AUSSIE MANUFACTURING PLANT

Digital Equipment Corporation has established an Australian manufacturing plant, in the Sydney suburb of Lane Cove. Using the new facility and with the involvement of local companies, Digital plans to increase its hardware exports by 100% per year over five years, and to approximately $A70 million by 1992.

Digital plans to manufacture 11 network and communications hardware products in Australia for export to the Pacific Rim and world-wide. Six products are currently being manufactured in Australia, three of them having been engineered locally. These are being manufactured at the Lane Cove facility, at which more than 70 staff are employed.

Through its Partnership for Development agreement with the Government, Digital will progressively increase exports to $100 million per year. Australian manufacturing will account for over half of this total. Petre Seuffert, Digital's director of Australian manufacturing, said that Australia's proximity to the emerging markets of Asia makes local manufacturing a viable global exercise for Digital.

"While the Partnership agreement provided an impetus to begin manufacturing in Australia at this time, we can say that the program has now reached 'critical mass' and will continue independently of the Partnership agreement," Seuffert said.

Digital is concentrating the manufacture of network and communications hardware products in Australia. Seuffert explained, "Australia is already a centre of networking and communication expertise, partly because of having a relatively small population spread over a large land mass. We are building on this expertise to make Australia an exporter of network and communication technology to the world."

NEWS

CONVERTER FOR PABX'S

Telecom Australia has launched a new product which allows businesses to use the latest ISDN technology without overhauling their office systems. The new product has been jointly developed by Telecom and Australian telecommunications supplier Jtec, and is one of the first products to take advantage of Australia's world leading Integrated Services Digital Network, introduced in Australia in July 1989. ISDN combines voice, data and video, in digital form.

The Macrospan 1000 multiplexer effectively converts analog signals into a digitised form meaning that business customers will be able to connect to ISDN without having to upgrade their non-compatible PABX's.

National Manager for Telecom ISDN Services Val Kangsanant says that the introduction of ISDN Macrolink ahead of other nations, has opened up unique opportunities for Australian industry.

"Local manufacturing and software industries have been given a rare opportunity to develop network equipment and customer terminal products for Macrolink connection ahead of other nations", said Ms Kangsanant.

"This not only stimulates home grown technological development and expertise, but also enhances Australia's export opportunities – Jtec is an example of local companies taking advantage of the opportunity".

DEATH OF INTEL FOUNDER, IC INVENTOR

Dr Robert Noyce, founder of Intel Corporation and one of the inventors of the integrated circuit, has died at his home in Austin, Texas at the age of 62 after suffering a heart attack.

As well as being one of the two independent inventors of the IC, Dr Noyce also played an inportant role in Intel's development of the first microprocessor chip – the 4004, which effectively began the microcomputer revolution. In 1979 he was awarded the National Medal of Science by President Carter, and then received the National Medal of Technology from President Reagan in 1987.

For the last couple of years he had been president and chief executive of Sematech, the Austin-based research consortium organised to help the US chip industry 'catch up' with Japan.

Telecom Australia and IBM Australia/NZ have agreed to develop co-operatively 'end-to-end' information services, beginning with a 2Mbps interface between IBM's Token Ring LAN and Telecom's FASTPAC network. Here IBM's MD Brian Finn (L) and Telecom's MD Mel Ward clinch the deal.

NULLABOR TRAINS GET PHILIPS UHF MOBILES

Australian National Rail has awarded Philips Telecommunications and Data (TDS) a $300,000 contract to supply more than 250 of its locally manufactured FM91 T/band UHF mobile radio transceivers.

The FM91's will form the mobile component of Australian National's 45 base-station radio network, operating via a new fibre optic communication link across the Nullabor Desert.

The FM91 mobiles are being installed on road and rail-based maintenance vehicles and will be used in conjunction with the optical fibre system.

The mobiles will be part of a communication network designed to replace the previous open wire pole telephone system, running parallel to the line for more than 1600 kilometres. The pole line, installed 10 years after the line was formally opened in 1916, has been in constant use until the changeover to fibre optics in April.

SEMI MEDAL FOR 'MEGA PROJECT' LEADERS

For their services as leaders of the European Mega Project, Dr Willy Beinvogl of Siemens and Dr Roel Kramer of Philips have been awarded the SEMI medal, in recognition of their contribution as project leaders to the establishment of a European industrial co-operation.

The objective of the co-operation, which encompassed research, development and manufacturing technology, was the achievement of world-class standards in the sub-micron circuits. The success of this project, according to the SEMI organisation based in the USA, paved the way for continued European co-operation in the area of semiconductor manufacturing.

As part of the Mega Project, which ran from 1984 to 1989, Siemens and Philips invested a total of DM2.4 billion (approx. $A2 billion) towards the development of a sub-micron memory product ready to go into production. Siemens had concentrated its efforts on dynamic memories (DRAM) made in CMOS technology. By starting 4Mbit DRAM production in the third quarter of 1989, the goal of closing the technological gap to world leaders was reached.

SEMI (Semiconductor Equipment and Materials International), the organisation sponsoring the award, is an international association of over 1300 companies which are active in the field of semiconductors. The award winners were selected by a European panel which comprises 12 representatives from industry and research institutes.

SYDNEY FIRM MAKING TOROIDAL TRANSFORMERS

Toroidal transformers offer higher efficiency and lower leakage flux than standard E-I cored types, but in Australia they've traditionally been higher in price due to the specialised winding techniques required and the absence of local manufacturers.

The situation has changed, however, with Sydney firm Tortech now set up and producing a range of toroidal transformers at its factory in North Strathfield. The range includes models from 30VA to 2500VA, and Tortech's winding machines can provide an optional electrostatic shield if required. An outer magnetic shield can also be provided if necessary, to achieve further reduction in leakage flux.

A range of transformers rated from 50VA to 300VA and approved to AS 3108-1984 is also available.

Tortech says that because of local manufacture, plus the use of highly efficient toroidal winding machines, its transformers are very price competitive.

Further details are available from Tortech at PO Box 194, North Strathfield 2137 or phone (02) 736 1516.

NEWS BRIEFS

- ***Promark Electronics*** has opened a South Australian office, which will be managed by Mark Chapman. The address is 297 Pirie Street, Adelaide 5000 and the phone number is (08) 236 0108.
- Tim Wortman, who established the Marconi Instruments operation in Australia and has more recently been Australasian Business Manager for Philips-Fluke, has just established his own test and measurement distribution firm. Called ***Tech-Fast T&M***, the company will provide fast delivery of DMMs, scopes, counters etc. The address is 14B Maxwell Street, Turramurra 2074, and phone number (02) 988 3865.
- ***Rhode and Schwarz*** has relocated to 63 Parramatta Road, Silverwater 2141 and the phone number is (02) 748 0155.
- US manufacturer of switching power supplies and DC-DC converters Power General has appointed ***Priority Electronics*** as its exclusive agent in Australia.
- ***Arista*** has made some new appointments, with Rudi Langeveld as Managing Director, Ken Crocker as Financial Controller, Peter Trautner as Warehouse Manager and Lorraine Lee as Sales Representative.
- Symetrix of USA has appointed ***Audio Telex Communications*** as the Australian distributor for its voice processing equipment. Audio Telex has offices in Sydney, Brisbane, Melbourne, Adelaide and Perth.
- Alcatel STC-Cannon Components has shortened its name to ***Alcatel Components***. The company does local manufacturing, assembly and testing of fibre optic connectors.
- ***Utilux*** has appointed Iain Hamilton, a qualified metallurgist, as the Quality Support Manager for the Head Office at Kingsgrove, NSW.
- Perth based component and equipment supplier ***Altronic Distributors*** has opened a wholesale branch office in Queensland, with Greg Liddelow as the State Manager. The address is Suite 204, Toowong Towers, 9 Sherwood Road, Toowong 4066 and the phone number is (07) 870 5161.
- ***Sony Australia*** has appointed Mr Tadashi (Gus) Ishida as its new Managing Director. Mr Ishida has been with Sony Corporation since 1963, spending 18 of these years in the USA.

$2M PROGRAM TO DEVELOP VIDEO CODEC

A joint $2 million research and development program has been announced by Telecom and Texas Instruments, to develop advanced 'in-office' video conferencing technology for Australia.

The new agreement is planned to result in the launch, in the second quarter of 1991, of new teleconferencing technology which converts vision signals into digital code. The digital encoder/decoder, called a digital codec, is to use the latest TI TM320 digital signal processing technology and incorporate several features which will greatly improve the quality of existing video conference systems.

In announcing the agreement, Telecom's Manager of Fast Packet Services, Mr Graeme Kidd said Telecom Australia placed considerable importance on co-operating with worldwide companies such as Texas Instruments in the development of equipment which will enhance and improve communications. Mr Kidd said the development of the digital codec coincides with the introduction of Telecom's new switched broadband data service 'FASTPAC'.

Fastpac will be the first national data service in Australia to use high performance broadband switching in an optical fibre environment.

AUSSAT GETS $100M CAPITAL INJECTION

Aussat, the national satellite carrier, is to be provided with a one-off injection of $100 million in equity. Minister for Transport and Communications Kim Beazley, said the decision followed consideration by Federal Cabinet of Aussat's financial needs.

"The existing regulatory regime has restricted Aussat's market and limited its options for diversification", Mr Beazley said.

"Although the company announced its first after tax operating profit in 1988/89, it has become apparent that market projections upon which decisions for Aussat's long term future were based are unlikely to be realised".

The long term future of all three telecommunications carriers, Telecom, OTC and Ausaat was addressed in the Review of the Ownership and Structural Arrangements among the three carriers. The review was conducted by the Department of Transport and Communications which was due to report to the Government by June 30.

Simple method of timing camera shutters

How do you check your camera's shutter opening times for the various speeds? Elaborate electronic timing systems are available, but they're expensive. Here's a simple technique which makes use of the camera itself and almost any surplus 1500rpm electric motor.

by WILLIAM JAMES

This article deals with checking the shutter speeds of cameras which can be controlled manually – which still comprise the bulk of the instruments in use today. You could take your camera to a repair shop having a modern electronic timer and for a fee, receive a certificate as to the accuracy of the shutter speeds. It is not always easy to find someone who has one of these timers and, in any case, there is the satisfaction of testing things for oneself. As it happens, it is quite easy to determine shutter speeds at home using relatively simple methods.

I have found that the apparatus most convenience for me consisted of the following:

1. A circular disc, 28 to 30.5cm in diameter.
2. An electric motor capable of driving the disc at known and steady speeds.

Under heading (1), I have in fact produced two discs. One, disc 'A' is 30.5cm in diameter and cut from 2.5mm aluminium sheet. Taking care to centre it correctly and using Araldite, I fixed an old 7" aluminium pulley. For added security, I also fitted self-tapping screws.

The face of the disc was undercoated and then sprayed with four coats of acrylic satin black. It was allowed to dry overnight, then an old 10" gramophone record was located in its centre, positioned horizontally and a heavy covering of white undercoat was sprayed round the exposed portion of the rim. When the record was removed, there was a clean black circle, 25cm in diameter, surrounded by a white rim, the main purpose of the rim was to exclude extraneous images.

A straight white line 1.5mm wide was then painted on the black circle, running from the centre to the edge of the white rim, using masking tape to protect the background. Two coats of white enamel were applied, the tape being removed before the second coat had set hard.

The second, disc 'B' is intended especially for the testing of focal plane shutters. The basic principle is to be able to photograph a thin white line on a drum rotating at right angles to the direction in which the shutter is travelling. Disc B reduces the distortions produced by FP shutters when photographing disc A.

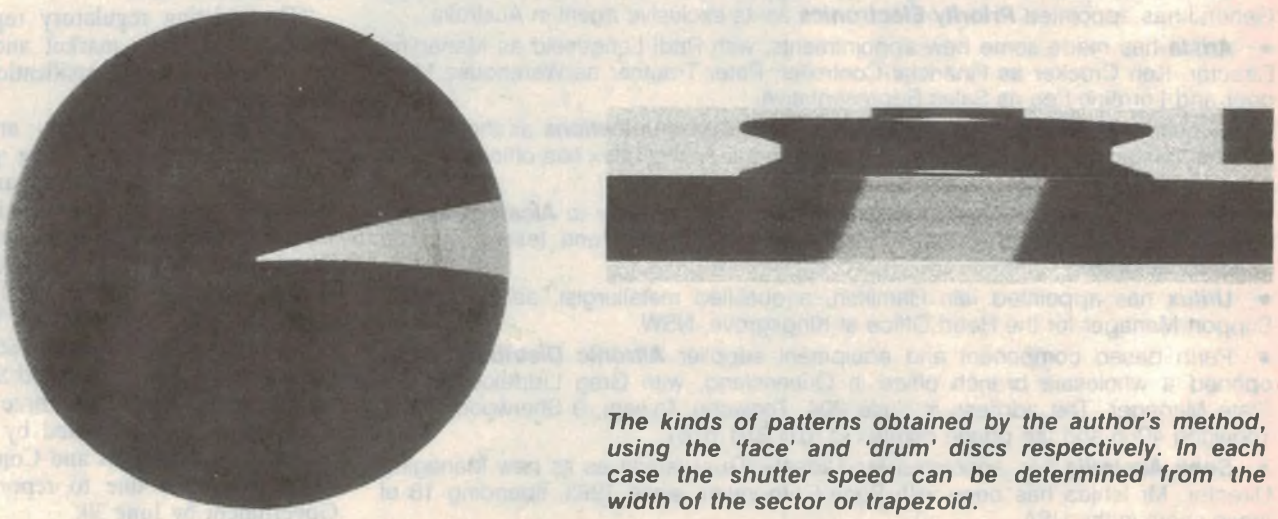
I used a new chopping board made for the kitchen. The board is a circular piece of hardwood, measuring 28cm in diameter by 2.3cm thick. An old 5" pulley was fitted to the back as per disc A.

The whole assembly was then sprayed black. Six white lines were painted on the rim of the disc, 1.5mm wide, at right angles to the circumference and equally spaced. Thus each line is 2.3cm long.

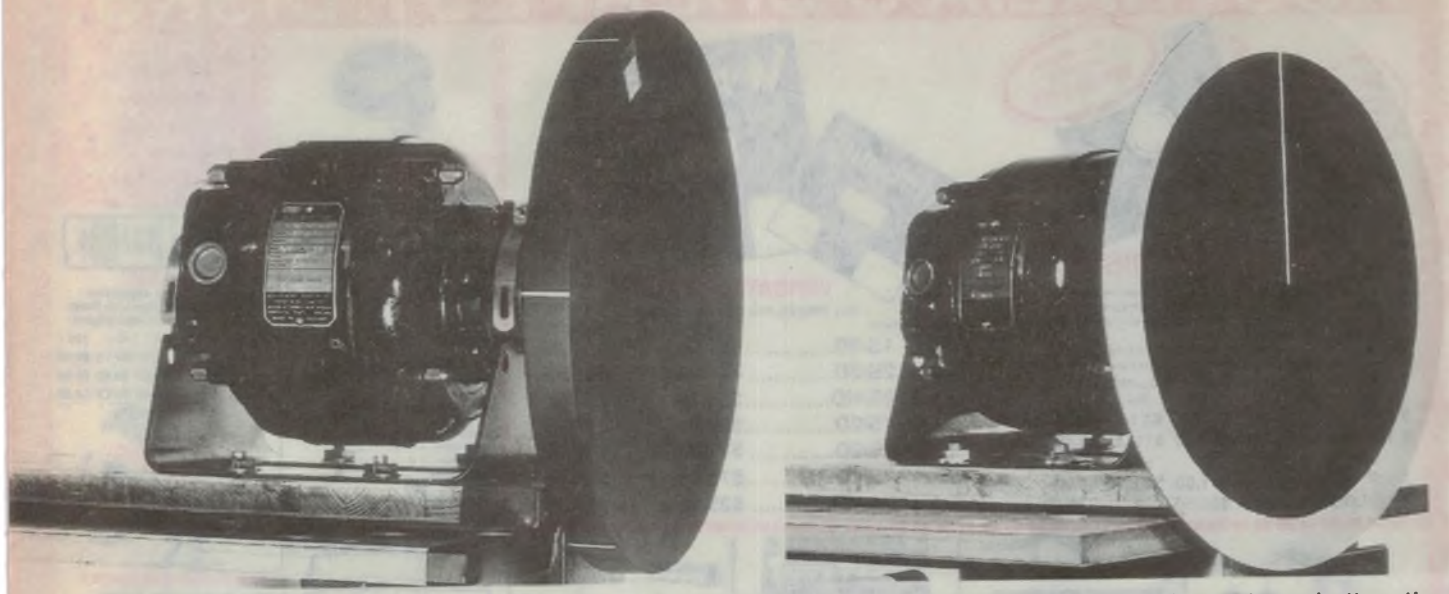
To drive the discs, I used an induction-type electric motor, 1/8HP and with a 1/2" spindle, from a scrapped tumble-dryer. It has a load rating of 1425rpm but the no-load spindle speed is higher.

When discs A and B were tried on the electric motor with direct drive the rotational speed was very steady, varying from 1496 to 1497rpm – checked by a digital tachometer, accurate to 1rpm. For shutter testing it is perfectly satisfactory to regard the motor as running at 1500rpm.

I have also experimented with various small electric motors. Using a lightweight disc these could be made to work quite well. Speeds were checked by an electro-mechanical counter activated by a bar magnet attached to the



The kinds of patterns obtained by the author's method, using the 'face' and 'drum' discs respectively. In each case the shutter speed can be determined from the width of the sector or trapezoid.



Two different types of disc can be used, with the 'drum' type at left somewhat better suited for focal-plane shutters than the 'face' type at right. Many different kinds of motor can be used.

disc and arranged to pass over a reed switch. I was never able to get a reasonably priced counter to work reliably above 700rpm, although rated higher. However, motors can be geared up as well as down and a dependable 1400rpm was attained using parts from my son's discarded Meccano set.

For the testing of camera shutter speeds the actual photography is simple. Mount the electric motor firmly. Fix disc A securely to the spindle and adjust the motor to get the disc vertical. Load camera with Kodak T-MAX 3200 film, mount the camera on a tripod, and line it up to photograph the disc, filling the frame as fully as possible and focus carefully.

If this film is not available, choose the fastest black and white film you can get and experiment with 'push-development'. If the camera has no close-focusing facility, use a supplementary lens.

Two photographic lamps will suffice, one on each side of the disc at about one metre from the centre and at an angle of 45°. The exposure information assumes No.1 photoflood bulbs.

Start the motor and make exposures as follows, three at each setting:

1/1000 at f/2.8 and f/4;
1/500 at f/4 and f/5.6;
1/250 at f/5.6 and f/8;
1/125 at f/8 and f/11
1/60 at f/11 and f/16

Process film in T-MAX developer for 11 mins at 21°C.

The resulting negatives will have black and grey areas. The white rim will show up as pure black. The circle will be a light-grey colour and will have a dark-grey sector, the sector perhaps being an irregular shape.

After the negatives have dried, put one in an enlarger and project its image onto a sheet of white paper. With a hard, sharp pencil cross-mark the centre of the disc and the two points on the circumference defining the outer limits of the dark-grey sector. Remove paper, draw lines from the centre of the circle to the two outer points, then with a protractor, measure the angle formed by the radial lines.

For a speed of 1500rpm the correct angles for the shutter speeds listed, ranging from 1/1000 to 1/60 sec, are as follows: 9, 18, 36, 72 and 144 degrees.

You can easily calculate the appropriate angle for any shutter setting at any rotational speed. The formula is

$s = (360 \times a)/b$

where 's' is the shutter speed, 'a' is the number of revs per *second* and 'b' is the measured sector angle in degrees.

While shutters of all types will give some distortion of a fast-moving object, the inter-lens shutters are very much better than the focal plane type. In many of the negatives radial lines will be curved, both bending in the same direction, unless a sector is large, when the curvature can be in opposite directions. The points for angle measurement should be taken at the circumference and at the two points, on a circumferential line, where the radial lines show the maximum curvature. You may well find, as I have often done, that the two angle measurements are the same. Failing that, take an average reading of the two angles and you will get an acceptable result.

Disc B provides a better way of testing focal plane shutters. Using a spirit level, position one of the white lines on the rim horizontally in relation to the centre of the disc and ensure that the camera is set up on a tripod so that this line is parallel to the centre of the lens and that the lens flange is vertical. Use a standard lens. Those of longer or shorter focal length will introduce optical and mathematical complications.

The disc should be running at right-angles to the direction of shutter travel, thus a camera with a vertical shutter should have its body mounted vertically. For a 35mm camera, fill the frame to an image size of about 20mm and just be able to see in the viewfinder, the two white lines on opposite sides of the 'base' line. Focus on this line.

There is no way of ensuring that an exposure with the disc running will produce an image in the centre of the negative. However, I have found in practice that, on average, at least one in every six exposures will have an image of a line on or near the centre of the disc.

For assessment, a selected negative is enlarged full-sized, i.e., to the width of the rim. The image will be a parallelogram, but that will be the only apparent distortion. The fast-moving vertical shutters will give cleaner images and less distortion.

Mark the edges of the image using masking tape, swing the enlarger head away and switch-on the ordinary lights. With a magnifying glass measure carefully the distance between the two edge

Continued on page 144

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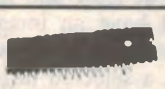

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Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

RECIEVER SPECIFICATIONS
Recieving Freq: 37.1MHz
Output Level: 30mV (maximum)
Recieving System: Super heterodyne crystal oscillation
Power Supply: 9V Battery or 9V DC power adapter
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
Weight: 220 grams

Cat A10452 R.R.P. $113
Our price, $99!

RS232 BREAK OUT BOX

A simple way of monitoring RS232 interface lead activity. Pocket sized for circuit testing monitoring and patching. 10 signal powered leds and 2 spares, 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

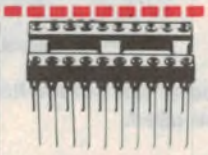
SPECIFICATIONS
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket
Indicators: Tricolour LED's for TD RD RTS CTS DSR CD TC RC DTR IE ITC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black high impact plastic
Dimensions: 85 x 95 x 30mm

X15700 $94.95

PANEL METERS GALORE!

We have a great range of panel meters at great prices!

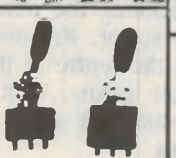
Cat No.	Description	Price
Q10500	MU45 0-1mA	12.50
Q10502	MU45 50-0-50uA	12.50
Q10504	MU45 0-100uA	12.50
Q10510	MU45 0-5A	12.50
Q10518	MU45 0-1A	12.50
Q10520	MU45 0-1A	12.50
Q10525	MU45 0-20V	12.50
Q10530	MU52E 0-1A	14.50
Q10533	MU52E 0-5A	14.50
Q10535	MU45 VU PMetre	14.95
Q10538	MU65 0-50uA	16.95
Q10540	MU65 0-1mA	16.95
Q10550	MU65 0-100uA	16.95
Q10560	MU65 0-20V	16.95



WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin plated phosphor bronze

Cat No.	Description	1-9	10+
P10579	8 pin	$1.50	$1.40
P10580	14 pin	$1.85	$1.70
P10585	16 pin	$1.95	$1.80
P10587	18 pin	$1.95	$1.80
P10590	20 pin	$2.95	$2.70
P10592	22 pin	$2.95	$2.70
P10594	24 pin	$3.95	$3.50
P10596	28 pin	$3.95	$3.50
P10598	40 pin	$4.95	$4.50



TOGGLE SWITCHES

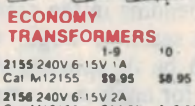
Cat No.	Descript	1-9	10+
S11010	S.P.D.T	$0.90	$0.80
S11020	D.P.D.T	$1.10	$1.00

QUALITY 3mm LEDS

Cat No.	Col.	1-9	10+	100+
Z10140	Red	$0.15	$0.12	$0.10
Z10141	Grn	$0.20	$0.15	$0.12
Z10143	Ylw	$0.20	$0.15	$0.12
Z10145	Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

Cat No.	Col.	1-9	10+	100+
Z10150	Red	$0.10	$0.09	$0.08
Z10151	Grn	$0.15	$0.12	$0.10
Z10152	Ylw	$0.15	$0.12	$0.10



ECONOMY TRANSFORMERS

	1-9	10+
2155 240V 6-15V 1A Cat M12155	$9.95	$8.95
2156 240V 6-15V 2A Cat M12156	$14.95	$13.95
2840 240V 9V CT Cat M12840	$5.95	$4.95
2851 240V 12-6V CT 150mA Cat M12851	$5.95	$5.50
2860 240V 15V CT 250mA Cat M12860	$5.95	$4.95
6672 240V 15-30V 1A tapped Cat M16672	$14.95	$13.95

ELECTRET MIC INSERTS

With pins for easy board insertion
Cat C10170

1-9	10+	100+
$1.20	$1.00	$0.90

CAR ANTENNA BOOSTER

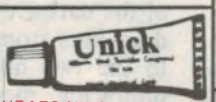
- In-line instalation
- 12V boosts 100%

Cat A12073 $7.95

CHROME LED BEZELS

9mm hole, available 3 colours

Cat No.	Desc.	Price
S14030	Red	$1.20
S14032	Green	$1.45
S14034	Yellow	$1.45



HEATSINK COMPOUND

Heatsink compound is applied to the base and mounting studs of transistors and diodes. It maintains a positive heatsink seal that improves heat transfer from the device to the heatsink thus increasing overall efficiency.

H11800 (10g) $2.00
H11810 (150g) $14.95

CODE KEY PAD

- Telephone type digital keypad
- Four digit changeable code
- Over 5000 possible combinations
- Power consumption 5mA standby 50mA alarm
- Two sector LED and 1 arm LED
- Wrong number lockout
- 12V DC operation
- Relay output
- Panic button
- Normally open tamper switch
- Dimensions 145 x 100 x 37mm
- ACP3 compatible

Cat A13014 R.R.P. $79.95
SPECIAL, ONLY $69.95

DB25 CONNECTOR SPECIALS!

	1-9	10+
P10884 DE9P	$1.00	$0.70
P10885 DE9S	$1.00	$0.70
P10890 DE9C	$1.00	$0.80
P10891 DA15S	$1.00	$0.80
P10892 DA15C	$1.00	$0.80
P10894 DA15P	$1.00	$0.80
P10902 DB25C	$1.00	$0.80
P10900 DB25P	$1.00	$0.80
P10901 DB25S	$1.00	$0.80

DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY RS232 X19120 ONLY $39
4 WAY RS232 X19125 ONLY $59
2 WAY Centronics X19130 ONLY $49
4 WAY Centronics X19135 ONLY $59

MEMORY

	1-9	10+
1 M/B 80NS.	$24.95	$22.95
4164-15	$4.95	$4.50
4164-12	$5.95	$5.50
41256-15	$7.50	$7.00
41256-12	$8.50	$8.00
41256-10	$9.50	$9.00
41256-08	$9.90	$9.50

MIDRANGE HORNS

Use these quality, all metal, Piezo tweeters for great top end sound in your band speakers, disco sound system, etc. Rated at 30 watts RMS in a system they will handle over 100 watts RMS.
Two sizes to choose from:
Size: 4 x 10 1/2
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 1.5kHz - 14kHz
Dimensions: 102 x 267 x 177mm
Cat C92082 Normally $49.95
This month only $39.95

Size: 3 x 7
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 2kHz - 15kHz
Dimensions: 76 x 177 x 145mm
Cat C92084 Normally $29.95
This month only $24.95

SUPER HORN TWEETER

- Requires no crossover and handles up to 100W!
- Sensitivity 100dB/0.5m
- Frequency Response 3kHz-30kHz
- Impedance 8 OHMS
- Size 96mm diameter

Cat C12102 Normally $12.95
SPECIAL, ONLY $9.95

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SYDNEY: 74 Parramatta Rd, Stanmore, NSW. Phone: (02) 519 3134
MELBOURNE: 48 A'Beckett St, Phone: (03) 663 6151
NORTHCOTE: 425 High St, Melb. Phone: (03) 489 8866
CLAYTON MAIL ORDER: 56 Renver Rd, Phone: (03) 543 7877, Fax: (03) 543 2648

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20 M/BYTE HARD DISK

Drive with controller card. IBM* compatible. 12 month warranty

X20010 ..... ONLY $499

40 M/BYTE VOICE COIL HARD DISK

IBM* compatible. 28 msec access. 12 month warranty

Without controller ... $795

80 M/BYTE VOICE COIL HARD DISK

IBM* compatible. 25 msec access. 12 month warranty

Without controller $1195

QUALITY JAPANESE DRIVES!!

5¼" 360K DRIVE

- 500K unformatted
- IBM* XT* compatible

Cat.C11901 ..... $159

5¼" 720K DRIVE

- 1 M/Byte unformatted
- IBM* AT* compatible

Cat.C11906 ..... $195

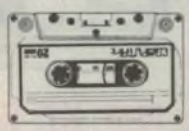
3½" 1.44 M/BYTE DRIVE

- Switchable 1.44 M/Byte formatted or 720K formatted
- Double sided, double density
- 5¼" mounted

Cat. C11911 ..... $299

CONTROLLER CARD TO SUIT

X18009 ..... $80



DATA CASSETTES

Save a small fortune with these quality 20 minute tapes. We import direct so we can pass on the savings

Cat. D11141

1-9	10+	25+
$0.95	$0.90	$0.80

240 VAC MAINS SURGE PROTECTOR / LINE FILTER

This unit has inbuilt M.O.V circuitry preventing any AC power spikes or surges entering the product it is protecting. An additional feature has been added to this unit. Line filtering and conditioning circuits have been included with the use of a torrid coil which suppresses electro magnetic interference (EMI) caused by other appliances operating in the AC system ie: computers, neon starters, refrigerators etc. The PAC 18 is sufficient for most domestic and some commercial applications.

- Approved by the Australian Dept of minerals and Energy.
- Appoval # N11361

X10092.....$69.95

PRIAM HARD DISK DRIVES

Priam presents the 700 series disk drives, members of a powerful PRIAM family of advanced 5 1/4" disk drives.

High capacity.

The 700 series disk drives offer unformated capacities ranging from 178 MBytes to 382 Mbytes of storage within a compact 5 1/2" package size.

SCSI.

The 700 Series drives offer the industry and ANSI standard SCSI interface for easy systems intergration. The interface is an embedded (within drive form factor) SCSI implementation. SCSI is an emerging standard for optimized system integration and performance. It frees your system from device-unique characteristics, such as head and track identification. With the 700 series PRIAM now offers the benifitof using an embedded SCSI in small microprocessor-based systems requiring high capacity, high performance disk drives.

High performance.

With a 20 msec. average seek time and a data transfer rate of 10 Mbits/sec, the 700 series offers the speed required for multi user, multi tasking applications.

Advanced Technology

The 700 series disk drive has an advanced linear voice-coil and closed loop dedicated servo technology and can be intergrated into workstations, multi user systems, and network applications.

Reliability

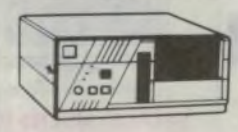
Every 700 series consists of features designed to maximize reliability and data integrity. Features such as an automatic actuator, landing/shipping zone and integral shock mounts guard against accidental loss of valuable data.

170 M/byte X20046.....$1490

380 M/byte X20048.....$ 2295

SCSI Interface card.....$129

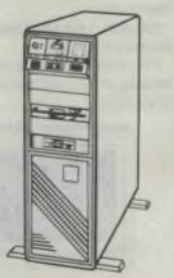
COMPUTER CASES



BABY AT* STYLE COMPUTER CASE

Small footprint. Features security key switch, 8 slots and mounting accessories. Size: 360(W) x 175(H) x 405(D) mm

X11093.....$99



25 MHZ TOWER SYSTEM

The 386 Tower PC is a high performance system that's IBM*AT* compatible. However, the 386 Tower PC gives you 4-8 times the performance.

FEATURES:

- Intel 80386- 25 Mhz microprocessor
- Switchable 25 Mhz
- 2 M/Byte fitted. Total memory expandable up to 16 M/Bytes.
- Up to 2 M/Byte or 8 M/Byte RAM modules on system board or on RAM card
- Option for 80287 & 80387 co-processor socket
- Operates in page mode with interleave memory subsystem
- Shadow RAM supported to allow system BIOS to be executed on system memory instead of slower EPROM
- Four 16-bit I/O slot. Three 8-bit I/O slot, and one 32-bit memory slot
- 8042 keyboard controller interface for AT* compatible keyboard
- Seven direct memory access (DMA) channels
- Chips and Technology chip set
- AMI 386 BIOS/Phoenix 386 BIOS/ AWARD 386 BIOS (AMI fitted)
- 50 M/Byte hard disk. 42 M/Byte formatted. Fast access
- VGA card

$4995

CPF CONTINUOUS POWER FILTER SPIKE ARRESTOR

The Fortron CPF Filtered Electronic Spike Protector provides a protective electronic barrier for microcomputers printers, telephone systems and modems electronic typewriters audio and stereo systems and other sensitive electronic equipment.

The CPF provides protection from dangerous electrical spikes that can cause anything from obvious damage (like immediate equipment failure) to less obvious harm that can drastically shorten a system's life.

CPF's superior circuitry design and semi conductor technology responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

Additionally, CPF's filtering capability helps eliminate troublesome and annoying interference, general hash created by small motors, fluorescent lamps, and the like that threaten the performance and shorten equipment life of unprotected electronic components.

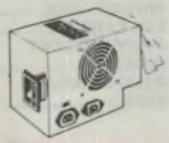
SPECIFICATIONS:

Electrical rating: 220-260 volts (AC) 50Hz 10 Amp

Spike/RFI Protection: 4,500 amps for 20m/second pulses

Maximum clamping voltage: 275V differential mode

Cat.X10088 ..... $69.95



150W SWITCH MODE POWER SUPPLY FOR IBM* PC*/XT* & COMPATIBLES

DC OUTPUT: +5/13A, -5V/0.5A, +12V/4.5A, -12V/0.5A

Cat. X11096 ..... $129

200W SWITCH MODE POWER SUPPLY FOR IBM* AT* & COMPATIBLE

DC OUTPUT: +5/16A, -5V/0.5A, +12V/5A, -12V/0.5A

Cat. X11097 ..... $199

180W SWITCH MODE POWER SUPPLY FOR BABY AT* COMPATIBLES

Cat. X11098 ..... $169

IBM* XT* COMPATIBLE CASE WITH AT* STYLING

Now you can have AT* styling in a XT* size case. Features security key switch, 8 slots, and mounting accessories.

Size: 490(W) x 145(H) x 400(D)

Cat. X11091 ..... $99

"NEW"

AUTOMATIC TELEPHONE ANSWER/ CALL CARD

TURN YOUR IBM* PC, XT, AT INTO A FULLY FUNCTIONAL ANSWERING MACHINE!!!

- A Sophisticated Voice coil mail system
- Auto answering / Dialing
- 100 voice mail boxes
- Password protection
- Message mailing
- Auto redialing
- Beeperless remote control
- Toll saver
- Call screening
- Electronic phone book
- Works in background
- Menu driven software
- Simple and concise operation

Traditional telephone answering machines are obsolete with the release of the NEW Voice Mail Card.

Not only can this card turn your computer into a 24 hour personal receptionist , but can answer with different phone messages for particular callers.

X19084.....ONLY $245

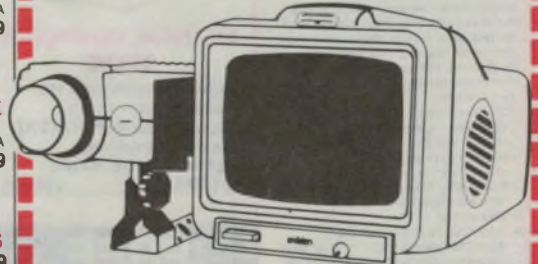
"NEW"

ONSIGHT VIDEO AND AUDIO/ VIDEO MONOTORING SYSTEMS

DEPENDING ON THE CAMERA'S PLACEMENT , YOU CAN SEE AND / OR HEAR IF YOUR CHILD IS AWAKE, SEE AND TALK WITH THE PERSON AT THE FRONT DOOR, OR SEE IF SOMEONE IS IN THE POOL.

WITH ITS BUILT IN INTERCOM , THE VM200 ONSIGHT LETS YOU CONVERSE WITH THE PEOPLE IN THE ROOM WHERE THE CAMERA IS MOUNTED.

OPTIONAL CAMERA'S , MONITORS, AND SWITCHERS ALLOWS YOU TO MONITOR SEVERAL LOCATIONS AT ONCE.



VIDEO ONLY.....$489

AUDIO / VIDEO.....$589

$ $ $ $ $ $

10 AMP CAR NOISE SUPPRESSOR

Heavy duty automotive electrical noise filter.
- Reduces alternator whine and impulse noise.
- Will take up to 40 amps.
- Used for stereos, and equalisers, CB's, etc.

A12102.....$19.95

AN EXTRA 5% OFF ALL OUR SYDNEY STORE'S PRICES ON TUESDAY

(SIMPLY BRING THIS AD IN WITH YOU)

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APPLE* COMPATIBLE SLIMLINE DISK DRIVE

Compatible with Apple 2 •

Cat. X19901 Only $159

FREE PACK OF S/S DISKS WITH EACH DRIVE!

APPLE* IIC COMPATIBLE DISK DRIVE

(including cable only $169

FREE PACK OF S/S DISKS WITH EACH DRIVE!

*Apple is a registered trade mark.

POSTCARD DIAGNOSTIC MODULE

Pinpointing component problems in IBM* compatible motherboards can take hours. Usually the whole system has to be working to isolate the troubled area. But not so with the new Postcard Diagnostic Module. So no other cards are necessary to test a bare motherboard.

"It now only takes seconds."

Simplified debugging for:
- Field service- for on-site repairs or maintenance depot work
- Manufacturing test- for burn in test flaws and to do quality control
- Inspection- Postcard simplifies incoming and outgoing test processes on stand

X18048.....$849

386SX 16MHz MOTHERBOARD

- Processor: 80386SX-16MHz (0/1 wait state)
- Co-processor:80387SX-16 (optional)
- CHIPS & TECH NEAT chipsets
- (SMT) Surface Mount Technology for chipsets & CPU
- Supports up to 2MB on board. (Sixteen 44256 and Eight 41256 sockets)
- Three 8 BIT slots
- Five 16 BIT slots
- Memory Expansion Slot
- Optional 2-8MB memory card
- Supports LOTUS-INTEL-MICROSOFT (LIM) Expanded Memory Spec. (EMS) version 4.0
- Supports Page Interleave Mode using 100NS DRAM
- BIOS: AMI or PHOENIX
- Turbo Light and Hardware Reset connector
- Keyboard or Hardware Reset connector
- Power Good Signal on board
- Baby size main board

PRICE BREAKTHROUGH

X18094.....$795

10 MHz XT* TURBO MOTHERBOARD

Increase the performance of you sluggish XT* approximately four times with this super fast motherboard.
- 8088-2 running at 10 MHz, no wait state
- Turbo/ Normal selectable
- 640K
- 8 Expansion slots
- 4 Channel DMA
- Keyboard port

Excluding RAM

X18032.....$149

Including RAM

X18033.....$295

BABY AT* MOTHERBOARD (WITHOUT MEMORY)

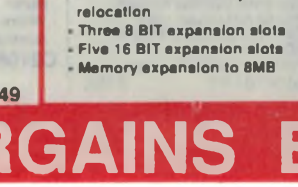
- 6/12 MHz system clock with zero wait state. 12 MHz, 1 wait state
- 80286-12 Microprocessor
- Hardware and software switchable
- Socket for 80287 numeric data co-processor
- 64K ROM
- Phoenix BIOS or Award
- 8 Expansion slots

Excluding Ram

X18202.....$375

Including 2M/Byte Ram

X18201.....$795



386 MAIN BOARD

- Intel 80386 CPU (20 MHz)
- Socket for 80387 Math co-processor
- 32 bit Memory BUS system
- Built-in speaker attachment
- Battery backup for CMOS configuration table and real time clock
- Keyboard controller and attachment
- 7 Channel DMA
- 16 Level Interrupts
- 3 Programmable timers
- 8 System expansion I/O slots: 5 with a 36 pin and a 62 pin expansion slots / 2 with only the 62 pin expansion slot / 1 with two 62 pin expansion slots (32 bit BUS)

Without RAM

X18103.....$1,195

Including 2 M/Byte RAM

X18107.....$1,625

20 M/BYTE HARD DISK

- Drive with controller card IBM* compatible. 3 month warranty

X20010.....only $499

40 M/BYTE VOICE COIL HARD DISK

- IBM* compatible. 28 msec access. 3 month warranty

With controller.. $795

80 M/BYTE VOICE COIL HARD DISK

- IBM* compatible. 25 msec access. 3 month warranty

Without controller. $1,295

330 M/BYTE VOICE COIL HARD DISK

- IBM* compatible. 18 msec access. ESDI. 3 month warranty

Without controller. $2,495

286 NEAT MOTHERBOARD

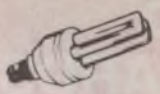
- Processor: 80286-12, -16MHz or -20MHz (0/1 wait state)
- Co-processor: 80287 (optional)
- CHIPS & TECH NEAT chipsets
- 1-4MB dual RAM socket
- 1-4MB module RAM socket on board
- 640KB-384KB memory relocation
- Three 8 BIT expansion slots
- Five 16 BIT expansion slots
- Memory expansion to 8MB
- Supports EMS 4.0
- Page Interleave Technology
- BIOS: AMI or PHOENIX
- Hardware and keyboard switchable Clock Speed
- LED speed display
- Power Good Signal on board
- Baby size main board

• 16MHz

X18090.....$595

• 20MHz

X18092.....$795



S14049 7W BC.....$34.95
S14051 11W BC.....$34.95
S14052 15W BC.....$34.95

S14053 12W BC.....$42.95
S14054 18W BC.....$44.95

FLOURO GLOBES!

DID YOU KNOW THAT SOME AUTHORITIES IN AMERICA NOW SUPPLY FLOURO GLOBES FREE OF CHARGE?

IT IS CHEAPER TO GIVE AWAY THE GLOBES THAN FACE THE POLLUTION AND FINANCIAL COST TO BUILD NEW POWER STATIONS.

IF THE SUPPLY AUTHORITIES RECKON THEY CAN SAVE MONEY THEN SO SHOULD YOU. HOW?

EACH FLURO GLOBE PRODUCES 5 TIMES THE LIGHT OF A NORMAL GLOBE. SO YOU NEED ONLY BUY A 20 WATT FLURO TO REPLACE THAT 100 WATT GLOBE. YOU SAVE MONEY BY USING POWER AT ONLY 20% OF THE PREVIOUS RATE.

IMAGINE CUTTING YOU LIGHTING BILL BY 80% !

THOSE CHEAP GLOBES POP ALL THE TIME AND THEY APPEAR TO COST MORE EVERY TIME YOU BUY THEM. WHEN YOU HAVE TO CLIMB ON CHAIRS OR UNDO FITTINGS TO CHANGE THEM YOU REALISE THE COST IS NOT JUST AT THE CHECK-OUT.

THE FLURO GLOBES LAST AT LEAST 8 TIMES AS LONG AS YOUR NORMAL GLOBE, YOUR TRIPS UP THE LADDER AND THE CALLS FROM YOUR CHILDREN OR ELDERLY PARENTS WILL COME LESS FREQUENTLY.

BUT PERHAPS THE BIGGEST SAVINGS IS IN OUR FUTURE. IF WE ALL USE LESS POWER, WE NEED DIG LESS COAL, USE LESS WATER WASHING IT, AND LESS ENERGY TRANSPORTING IT AND ULTIMATELY LESS DE-STRUCTION OF OUR ENVIRONMENT.

SO NOW YOU CAN SAVE ON YOUR LIGHTING BILLS AND BE LIKE EVERYONE ELSE AND CARE A LITTLE MORE FOR YOUR ENVI-RONMENT.

TAKE YOUR STAND NOW AND INSIST ON FLUROGLOBES FROM ROD IRVING AND TELL YOUR POLITICIANS WHAT YOU ARE DOING AND WHY. PERHAPS THE MESSAGE WILL GET THROUGH AND THEY WILL ALSO SEE THE LIGHT....

IBM* PC/AT* DECODED I/O CARD

This card is designed for the IBM* PC/AT* expansion slot and includes data buffering and address selection. The wire wrap area features plated through holes. Extremely useful for R&D, it's address range is 0280H to 72 F7H. • -5V, • -12V fuse protection and has location for D type 37 pin or D type 25 pin connector.

H19125.....$99

MAIL ORDER HOTLINE 008 33 5757

ROD IRVING ELECTRONICS

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Phone: (03) 489 8866

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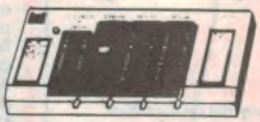

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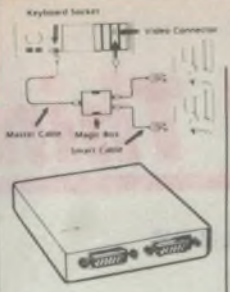

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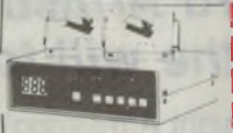

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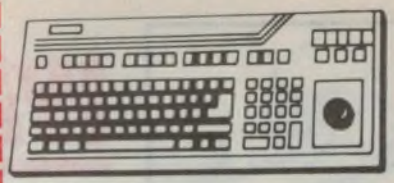

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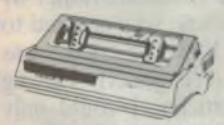

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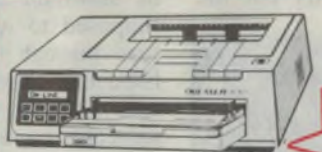

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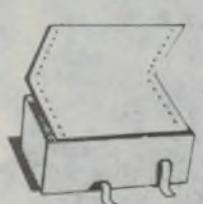

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When I Think Back...

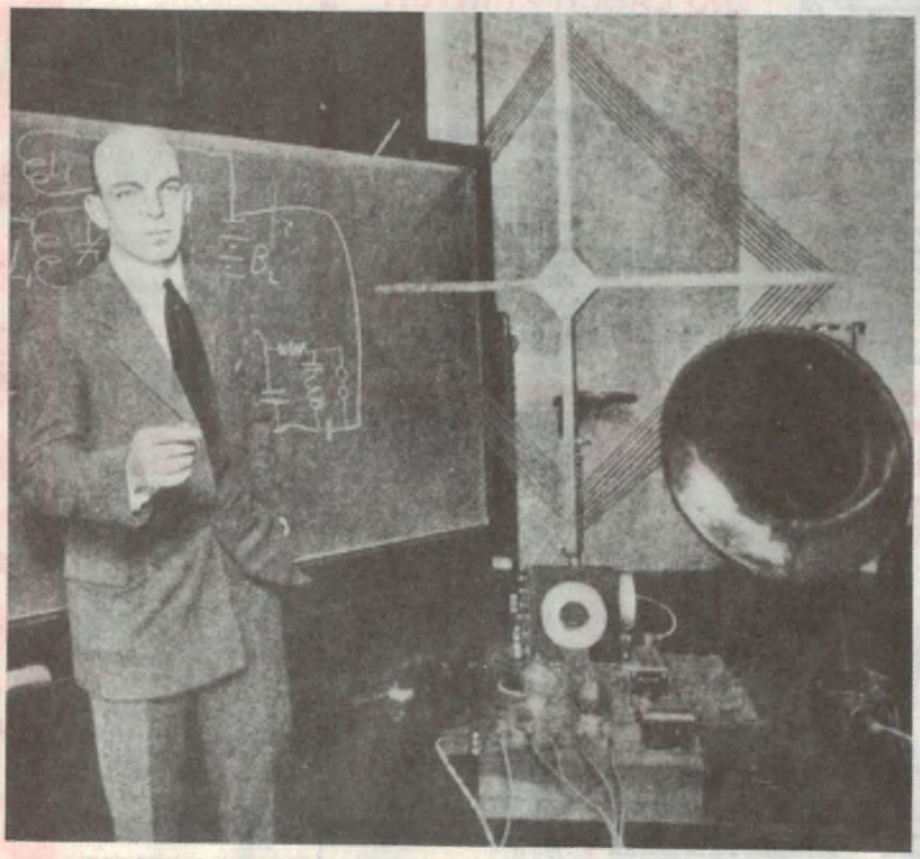
by Neville Williams

Major Edwin Howard Armstrong: a genius who lost the will to live – 2

Although with the benefit of hindsight Armstrong's main achievements were almost certainly the discovery of the valve oscillator and the development of the superhet, his inventive genius didn't stop there. Another of his inventions was the super-regenerative receiver, which played a worthwhile – though short lived – role in opening up VHF/UHF communications. He also played a key role in the development of FM broadcasting.

Armstrong's next invention came hard on the heels of the superheterodyne. Spelt nowadays without the hyphen as 'superregeneration', it was patented in 1922 and described in a paper to the Institute of Radio Engineers (USA) in June of that year.

Surprisingly, I found no less than eight articles on the subject in a bound volume of *The Australasian Wireless Review* for 1923, directed to readers who might be inclined to try out the new circuit.



From the June '23 issue of 'Australasian Wireless Review' Howard Armstrong is pictured in the formal role of inventor and academic, demonstrating his superregenerative receiver. Contrary to some reports, he always regarded the superhet as the more elegant approach.

Unfortunately, none had the advantage, like the superhet article above, of being written by the inventor; rather by unnamed staff members, who seemed to be uncertain as to how the circuit was supposed to work (see panel). Having read through the articles, I could only hope that they meant more to enthusiasts working with prototypes than to someone merely reading the text, the best part of 70 years later!

I was reminded, however, of a time when the amateur fraternity – myself included – was probing the VHF and UHF spectrum using simple modulated-oscillator transmitters and superregenerative receivers.

Although brief, the literature from that period was somewhat more enlightening.

It was pointed out that superregeneration could be regarded as a potential elaboration of any regenerative detector, capable of sustained oscillation at the required signal frequency.

It involved the addition of an external oscillator, which could modulate the grid and/or anode voltage of the detector so that its signal frequency oscillation would be interrupted at a suitable supersonic frequency. A simpler alternative was to choose the value of the grid capacitor and resistor to achieve an artificially long time constant, so that the grid would 'block' or 'squegg' at a supersonic frequency when oscillating, thereby functioning as a 'self-quenched' superregenerative detector.

Basic principle

The accepted, if rather superficial, ex-

planation of how the circuit worked started from the premise that when an ordinary regenerative detector went into oscillation, its operating point (or bias) shifted in such a way that extra positive feedback did not further increase detection efficiency. As well, the audible beat note between the incoming and local signal corrupted the modulation.

In a superregenerative receiver, the detector effectively 'sampled' the incoming signal at a supersonic rate with high positive feedback – but with less effect on efficiency – providing a substantial increase in sensitivity and obviating the audible heterodyne.

Even so, the superregenerative circuit had a few problems of its own: the need for special components to generate the quench signal, and then to filter it out to prevent overload effects in the audio amplifier; uncertainty about circuit adjustment and behaviour; high noise level in the absence of signal; poor selectivity; and a tendency to radiate noise interference into nearby receivers.

According to *Electronics Weekly* Armstrong sold rights to the circuit to RCA for $200,000 plus 60,000 shares, most of which was absorbed by Armstrong's on-going litigation. For RCA, the 'superregen' circuit proved of little commercial value, although it was used from the 1930s onwards by amateur operators for simple receivers, and by modellers for radio control purposes.

Readers may be interested in a quote from the *ARRL Handbook* for 1936:

The student of the subject anxious to have a more thorough knowledge of theoretical considerations might well study the excellent technical treatment by Ataka in the August 1935 issue of 'The Proceedings of the Institute of Radio Engineers' (USA).

I have not seen it personally.

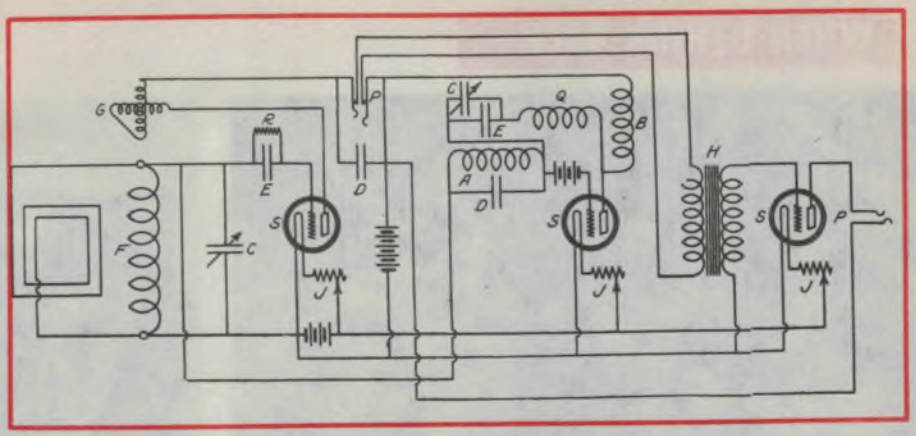


Fig.3: The 3-valve superregenerative circuit selected for construction and test by 'The Australasian Wireless Review' in 1923. On the left is the regenerative detector using a variometer for adjustable reaction. The quench oscillator (centre) feeds its signal to the detector grid. On the right is an audio amplifier stage. All valves are UV-201 tungsten filament triodes.

Frequency modulation

With his wide-ranging background, Armstrong was well aware of the problem posed by atmospheric and man-made interference. As far back as 1914, he had studied it in collaboration with Professor Pupin, but by 1922 both had accepted that sensitivity to interference was intrinsic to any receiver required to respond to variations in the *amplitude* of incoming signals.

So, while other engineers and experimenters continued vainly to dream about anti-static measures, Armstrong turned his attention to the possibility of a system which would depend on *frequency* modulation of the carrier wave – a method which would allow the receiver to be so designed that it would specifically *reject* amplitude modulation, and therefore noise interference as well.

Frequency modulation had been a long-time option, and Armstrong never claimed to have originated the idea. In his book *Radio Telephony* (Wireless Press Inc, 1918), Alfred N. Goldsmith PhD mentions FM, but discards it. But with other engineers rejecting it as impractical, Armstrong set about to demonstrate otherwise – winning, this time, the backing of GE (the General Electric Co, of Schenectady, USA).

As mentioned in earlier articles about Raymond Allsop and FM broadcasting in Australia, Armstrong's early research culminated in a paper published in May 1936 in *The Proceedings of the IRE* (USA), entitled 'A method of reducing disturbances in radio signalling by a system of frequency modulation'.

His claims were supported by an impressive practical presentation to the Radio Club of America, in the Pupin Hall of the Columbia University – an audience and a locale richly reminiscent of other days. The source of the signals was a 2kW RCA-built transmitter atop the Empire State building. Supporting papers were also delivered by Messrs Weir, Flyer and Worcester of GE.

Hassles with home-built superregen receivers:

The following are a few snippets from 1923 issues of *The Australasian Wireless Review*, which could hardly have been reassuring to would-be constructors:

March, p.19: *Many thousands of American amateurs are working hard to master the intricacies of the superregenerative circuit and it is hoped that Australian amateurs will not lag far behind in bringing the circuit into successful operation here.*

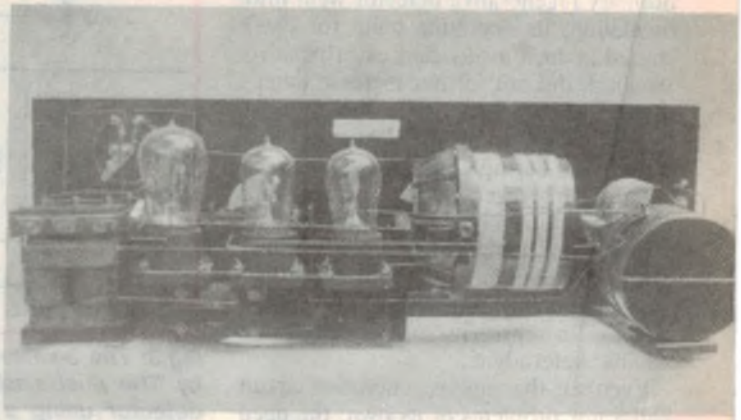
April, p.22: *Apparently it is only a matter of patience and experiment to get the circuit working correctly, as every change reveals some new feature of the circuit that seems to bring one nearer the goal.*

April, p.22: *The word 'roar' very appropriately describes the noise heard, as it is as loud as the safety valve of a steam engine blowing off. It convinces one that there is tremendous power in the circuit, if it can only be brought under control.*

April, p.27: *When the two valves are oscillating, the movement of any of the variable elements should produce a series of heterodynes or harmonics. Unless these are heard, there is something wrong and no progress can be made.*

June, p.26: *It will be noted that long ebonite handles control the moving elements, with the object of overcoming body capacity effect, which experiments with the Armstrong superregenerative circuit prove to be very great.*

August, p.40: *We have a good deal to learn about it yet to get maximum results, but we are satisfied in having, at last, made the Armstrong Super work.*



(Above). Headlined as 'The first Armstrong Super to work in Sydney' this superregenerative receiver was constructed by Mr Fry of the Universal Electric Company of 244 Pitt St, Sydney. Readers wanting to buy similar parts to those used were invited to contact the above company.

(Left). When Armstrong demonstrated the superregenerative receiver at Columbia University, the audience crowded around the display.

FM broadcasting

Within three years, Armstrong's dream was well on the way to becoming a reality. In April 1939, under the heading 'At Long Last – STATIC-FREE RADIO', the US magazine *Radio-Craft* carried an announcement by Armstrong that the world's first static-free broadcast station was currently being set up as a personal investment.

To be known as W2XMN, the station would be classified by the FCC as experimental, but would hopefully be granted a commercial licence if it proved successful. It would transmit from atop the Pallisades (New Jersey) near the George Washington bridge, on a wavelength of about 7 metres (40MHz) and would serve an area of about 100 miles (160km) diameter. It would broadcast programs originated by New York's hifi AM station WQXR, until such times that WQXR had installed its own FM outlet.

In the meantime, according to the article, two experimental FM stations were already in operation – one in Albany, NY, operated by GE and another installed by the Connecticut State College at Storrs, Conn. Six other experimental stations were being set up elsewhere by engineers who believed that FM had great potential.

GE, said the article, had begun manufacturing FM receivers and Edwin Armstrong is pictured with GE's Dr W.R.G. Baker checking out an 11-tube laboratory prototype.

Another picture shows Armstrong swinging in a boatswain's chair 400ft (120m) up on W2XMN's transmitting tower, adjusting the VHF antenna elements and cable feed system. Occupying several hours a day, spread over 2 months, this was described as the most difficult part of the whole project.

The development of FM broadcasting was interrupted by the war, however, with Armstrong granting free use of his many patents to the US Government and diverting his immediate attention to military radar.

After the war, FM broadcasting emerged as an outstanding success, spreading across America and into Europe and other technologically advanced nations – to the dismay of established AM commercial broadcasters. Millions of FM receivers have been built and sold around the world, virtually every one of them a superhet!

High personal cost

From amateur to academic, as an innovator, inventor and visionary, Edwin Howard Armstrong must rate among the all-time greats in the history of radio and electronics technology.

But at a personal level, his dedication and his unwillingness ever to 'let go' cost him dearly. He supported his convictions passionately and, when faced with litigation, he drained his emotional and financial resources to defend what he saw as principles. Although in no sense a recluse, his preoccupation with technical and business problems created a work overload, robbed him of relaxation and undermined his health.

The British pioneer, Captain H.J. Round was to say later: "Howard tried to do it all himself and it was too much even for his great intellect and personality."

Marconi's biographer, David Gunstan, adds the remark that Armstrong developed "an almost paranoid conviction that he was the victim of conspiracy".

His career ended on January 13, 1954, exactly 41 years to the day in 1913 when the 22-year old graduate of Columbia University had some circuit diagrams witnessed by a notary public.

Having written a letter to his wife, Edwin Howard Armstrong put on his hat, overcoat and gloves as if to go out for the evening. But instead, say the reports, he climbed through his 13th-story apartment window and crashed to his death on a third floor terrace. There his body remained until someone noticed it mid-morning the next day.

From *Electronics Weekly* I borrow this fitting tribute:

So passed from the scene a brilliant, controversial, inventive genius of whom it was said: the radio art owes more than to any other one man. Today there is no radio system anywhere in the world that does not use his ideas in some way.

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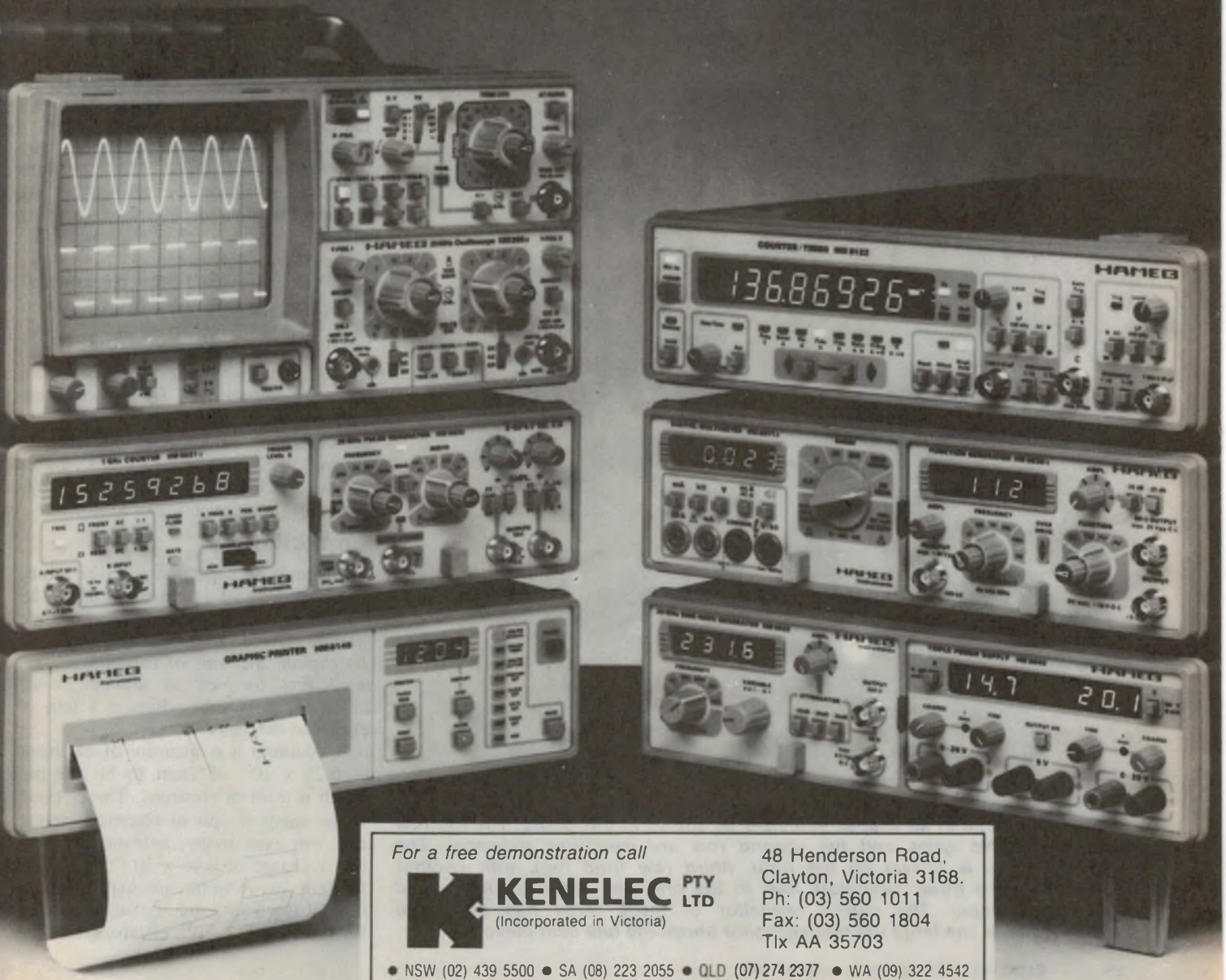

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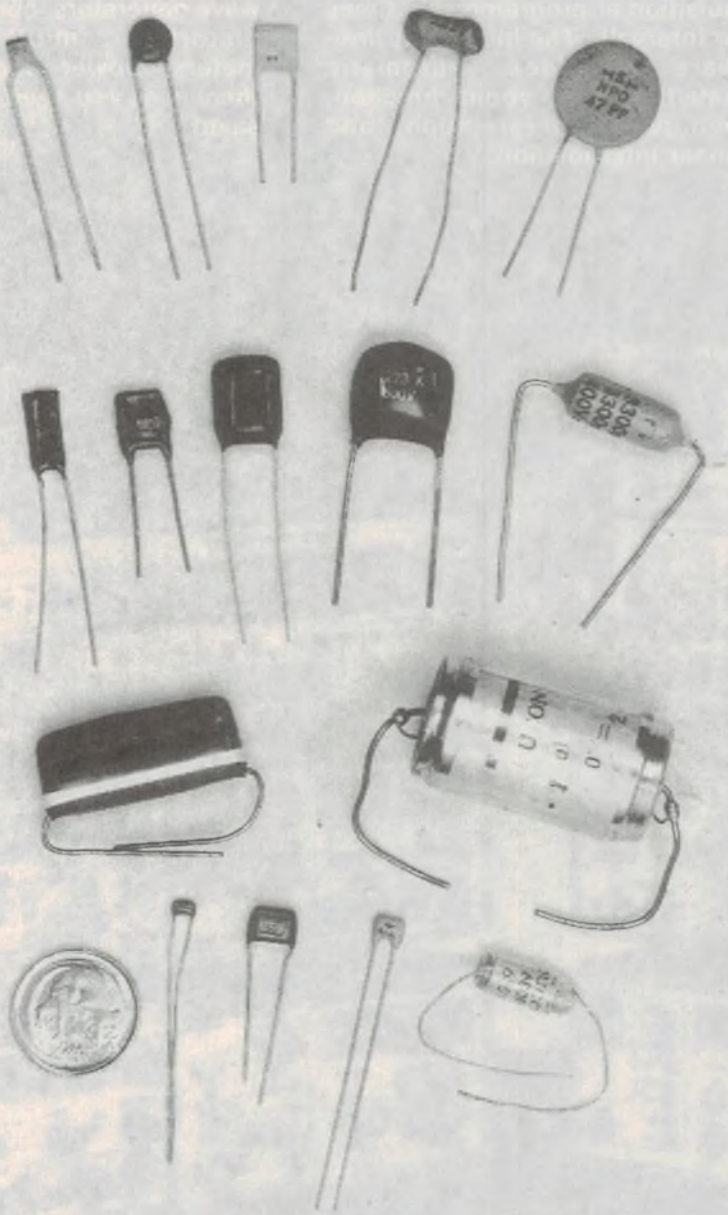
READER INFO No. 6

Basic Electronics – Part 6

Capacitors

The capacitor, next to the resistor, is the most commonly used component in electronics. In this chapter we examine the humble capacitor and show some of its many uses.

by PETER PHILLIPS



Capacitors come in all shapes and sizes as shown in this photo. The top row are all ceramic types and the second row are metallised polyester. The Styroseal type is shown on the right, (third row from top), with another beneath it. The three capacitors next to the one cent piece are monolithic types (sky caps). The centre capacitor of these three has the same capacitance as the large flat film capacitor above the one cent piece.

In the last chapter, we introduced capacitance as an electrical quantity. It was seen that a capacitor is simply two conductors separated by an insulator, and that despite this, a capacitor can conduct an alternating current. Interesting when you think about it: here we have a current apparently flowing through an insulator!

Of course, actual electrons don't pass through the insulator – rather the voltage across the capacitor produces an electric field which causes electrons to be attracted or repelled from each plate. The plates simply store the electrons, and the larger the plate area the greater the capacitance. Also, the thinner the insulator or *dielectric*, the greater the flow of electrons, proving that the thinner the dielectric, the higher the capacitance.

So how are capacitors constructed? How thin can the dielectric be made? And what materials are the plates made of? There are lots of different construction techniques, giving lots of different types of capacitors. That's our main topic in this chapter, along with a few mathematical facts about capacitance. As well, we look at combining a resistor and a capacitor to produce a timing circuit. Yes! Some electronics at last...

Capacitance

The unit of capacitance is the *farad, in recognition of Michael Faraday, the English scientist whose work we have already referred to in previous chapters. To explain the unit of capacitance, we need first to look at another term, called the coulomb*, which is a unit of electrical charge.

A coulomb is a quantity of electrons – 6.25×10^{18} of them to be precise, which is a lot of electrons. The electron is the smallest unit of electrical charge that can exist singly, and one electron has a charge of 0.16×10^{-18} coulombs. Current, as we've already explained is a *flow* of electrons, and one ampere is defined as 6.25×10^{18} electrons flowing

past a given point every second. In other words, one ampere is a flow of one coulomb per second.

You might wonder how this was all worked out in the first place, as electrons are too small to actually count. The credit goes to Robert Millikan (1868-1953), an American physicist who received a Nobel prize in physics for the experiments he conducted around 1908 to 1917 to determine the charge of an electron. Briefly, Millikan used vaporised droplets of oil that were sprayed from an atomiser. He measured the charge received by the drops as a result of friction, by balancing the gravitational force against an electrical force that could be measured very precisely.

From these experiments, he found the smallest charge received by the droplets to be 0.16 x 10^{-18} coulombs, and the next higher charge to be 0.32 x 10^{-18} - followed by 0.48 x 10^{-18} coulombs. He concluded that as the higher values were all multiples of the smallest value, the basic unit of charge, due to a single electron was 0.16 x 10^{-18} coulombs. From this, one coulomb is determined by taking the reciprocal of 0.16 x 10^{-18} which gives the value of 6.25 x 10^{18} electrons. Clever stuff!

Of course, gathering an electrical charge together requires setting up a potential difference, or voltage. So a charge in motion is current, and a charge that is stored (and therefore static) produces a voltage. Now, returning to capacitance, we can put this all together.

In the last chapter we explained that if a capacitor is connected to a DC voltage, a charge current will flow. Once charged, the capacitor will have a voltage across it.

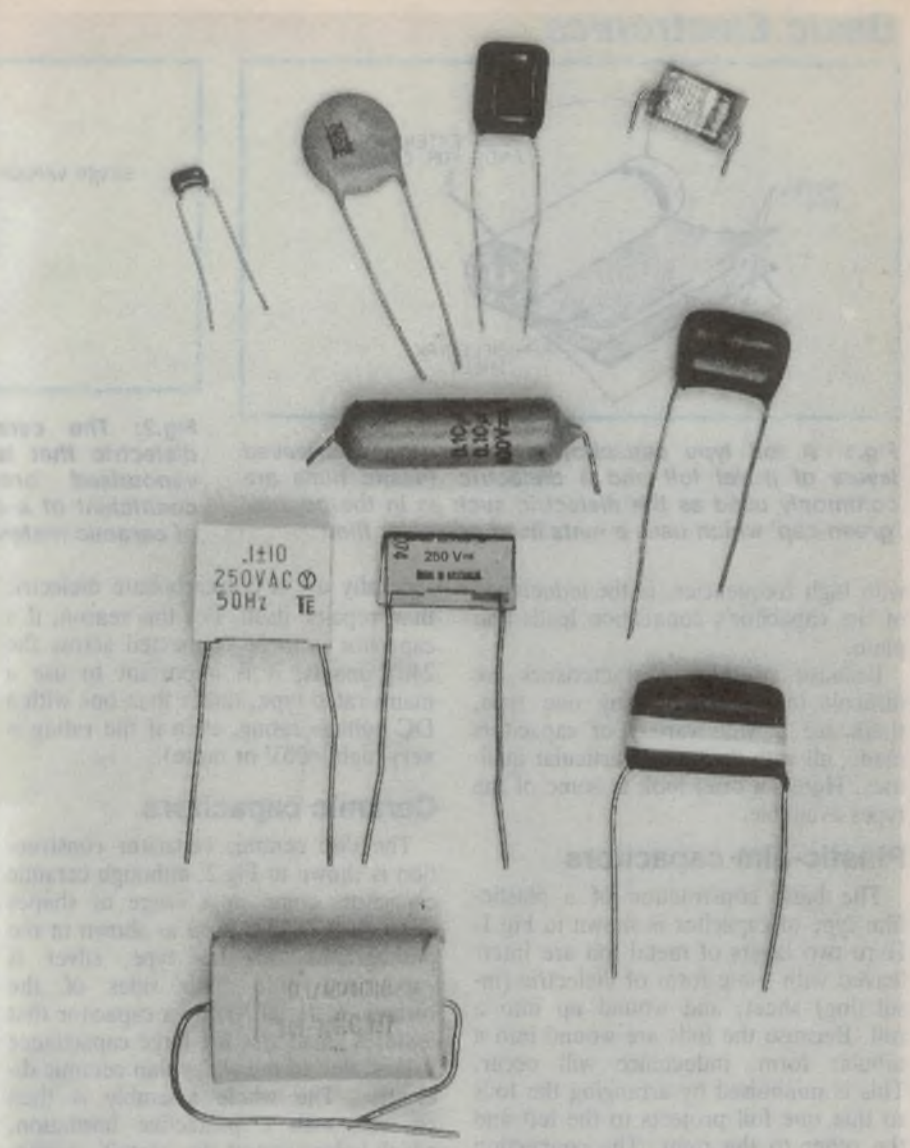
The relationship is simply this: *if a capacitor (C) takes a charge of one coulomb (Q) – which is a charging current of 1 amp for 1 second, and it is left with a potential difference (V) of 1 volt, then the capacitor has a capacitance of 1 farad.*

That is, C = Q/V

The farad is a very large unit of capacitance, and most practical capacitance values range from millionths of a farad to billionths of a farad. Putting this into scientific notation, the usual values of capacitance are the *micro*farad, written as uF and expressed mathematically as 10^{-6} farads; and the *pico*farad, (pF = 10^{-12} farads).

It is unusual to have capacitance values greater than 10,000uF and smaller than 1pF. Typical maximum values are 1000uF, (sometimes called a *millifarad*) and the more common values range around fractions of a microfarad. Another way of expressing fractions of a microfarad is with the term *nano*farad. The nanofarad (nF) equals 10^{-9} farads, and is roughly midway between the pF and the uF.

So that's the story on the unit of capacitance. To help readers relate the various multipliers used in capacitance values, we have reprinted a Reference Notebook on capacitors that appeared in the January 1989 edition of *EA*. If multipliers are still troubling you, you might like to refer back to the second part of this series, which was published in February 1990.



All the capacitors in this photo have the same value of 0.1uF. The large capacitor at the bottom has a rated working voltage of 1kV, and the two above it are designed to work across the 240V mains.

Capacitor types

So far we have explained quite a lot about capacitors. We've seen that they have *reactance* (previous chapter), that they pass AC but block DC, and now you also know about the farad. But how are they made? Good question, and one we can now explore.

Like most electronic components, there are several other characteristics about a capacitor, apart from the actual capacitance value that need to be considered. For example, we've shown that a charged capacitor will have a voltage across it. But what is the limit to this voltage? As well, the stability of the capacitance value with ageing and temperature change is an important characteristic. Then comes the physical size of the component.

Another important consideration, particularly if the capacitor is to be used

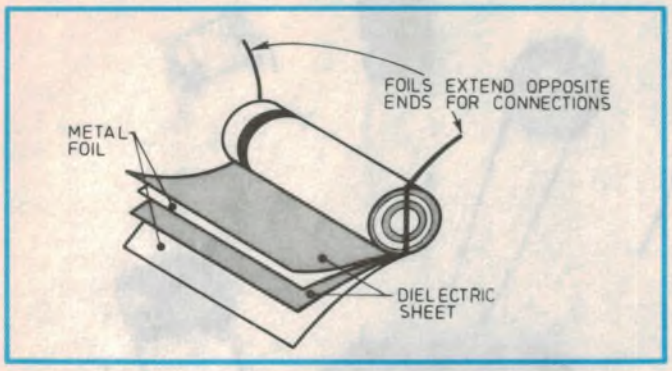


Fig.1: A foil type capacitor is made with interleaved layers of metal foil and a dielectric. Plastic films are commonly used as the dielectric such as in the popular 'green-cap' which uses a metallised polyester film.

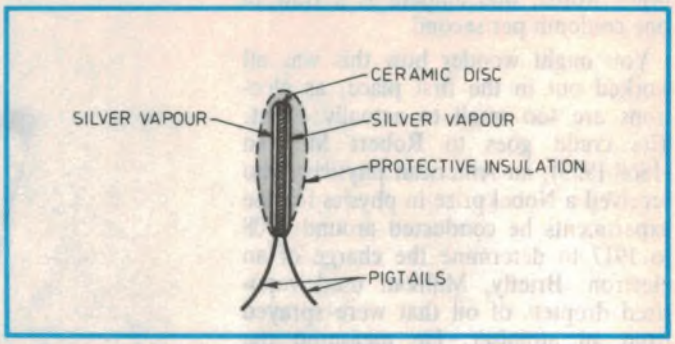


Fig.2: The ceramic capacitor has a thin ceramic dielectric that is coated either side with silver metal vapourised onto the ceramic. The temperature coefficient of a ceramic capacitor depends on the type of ceramic material used.

with high frequencies, is the *inductance* of the capacitor's connection leads and plate.

Because all these characteristics are difficult to address in any one type, there are a wide variety of capacitors made, all with their own particular qualities. Here's a brief look at some of the types available.

Plastic-film capacitors

The basic construction of a plastic-film type of capacitor is shown in Fig.1. Here two layers of metal foil are interleaved with some form of dielectric (insulating) sheet, and wound up into a roll. Because the foils are wound into a tubular form, inductance will occur. This is minimised by arranging the foils so that one foil projects to the left and the other to the right. The connection to each foil is then taken from the projecting ends, rather than simply connecting to the outer end of each foil.

Nowadays the dielectric for this type of construction is usually a plastic film, such as Mylar or polyester, replacing the paper dielectric that was used before the development of plastic films. The popular 'green cap' uses a metallised polyester film. Polyester capacitors are generally available in sizes ranging from 1nF (0.001uF) to 1uF, and have working voltages of 100V or more. They have good temperature stability, and reasonably low inductance. They are used in many areas of electronics, including audio systems, computers, radio and TV sets.

Another plastic-film capacitor is the 'Styroseal' type, which uses a polystyrene dielectric. These capacitors feature very low leakage, but are generally more expensive (and larger) than the polyester types.

Mains-rated capacitors (250V AC) generally use a polycarbonate dielectric that 'repairs' itself. For this reason, if a capacitor is to be connected across the 240V mains, it is important to use a mains-rated type, rather than one with a DC voltage rating, even if the rating is very high (630V or more).

Ceramic capacitors

The disc ceramic capacitor construction is shown in Fig.2, although ceramic capacitors come in a range of shapes other than in disc form as shown in the photographs. In this type, silver is vapourised onto both sides of the ceramic material, giving a capacitor that features small size for large capacitance values, due to the wafer thin ceramic dielectric. The whole assembly is then covered with a protective insulation, which helps support the 'pigtail' connection leads.

The type of ceramic determines the capacitor's *temperature coefficient*, or the amount by which the capacitance value changes per C°. Different ceramics are made that exhibit varying degrees of positive, negative or zero coefficients.

Some ceramic capacitors are made to withstand high voltages, but most are low voltage, high capacity types. As well, most small value capacitors (1pF to 820pF) are ceramic types, because of the low inductance inherent in the construction. Ceramic capacitors are use in digital circuits and radio/TV tuning applications.

The *monolithic* capacitor is another small size per unit of capacitance type, and is often classified as a ceramic capacitor.

Electrolytics

All of the construction types described so far are for values of around 5uF or less. Electrolytic capacitors use a chemical (aluminium oxide) for the dielectric, which allows a molecular thin layer, giving much higher capacities for a given size. Because the electrolyte forms the dielectric, these types of capacitors are *polarised*, meaning they must be connected with regard to the polarity of the DC voltage in the circuit.

As a general rule, the aluminium can is the negative end, although electrolytic capacitors are always marked to indicate the polarity. If the capacitor is connected with the wrong polarity the insulating layer will turn into a conductor, which not only reduces the capacitance, but allows the capacitor to conduct DC. This will cause the capacitor to heat up, and possibly explode. There are many tales of servicemen being hit in the face by an exploding electrolytic, so be careful!

Electrolytic capacitors range in size from 1uF to 10,000uF and more. They usually have a voltage rating marked on the can, and this value can vary from 25V to several hundred volts. Most types are either 25V or 63V rated, and the higher the voltage the larger the capacitor for a given size of capacitance. Electrolytic capacitors generally have a relatively high leakage, (the RBLL types have a lower leakage) and are used in low frequency applications, such as in power supplies and audio amplifiers.

The *tantalum* capacitor is an electrolytic type, but one that uses a tantalum dioxide dielectric, giving extremely low leakage and a very small size for a given capacitance. These types are more expensive than conventional electrolytics, and are more prone to exploding if connected with the incorrect polarity. They are used where low leakage and high stability is required.

Another rather interesting polarised capacitor is the so called 'super cap'. These capacitors feature incredible capacity for a small size, and values of 1 farad (yes, a farad, or a million microfarads) are available. These types are used in specialised applications, particularly as a backup voltage supply in a computer memory circuit. They are fairly expensive and only operate at low voltages.

Variable capacitors

Variable capacitors are used to tune a resonant circuit, and most radios use a variable capacitor driven by the tuning knob or dial as the means of tuning into a station.

The construction of a typical variable capacitor is shown in Fig.3, in which vanes attached to a shaft are interleaved with fixed vanes. Older style variable capacitors used air as the dielectric, and a bent vane would result in a short circuit. Today's types have a thin layer of plastic (Mylar or similar) between the vanes, which allows a much smaller size as the plates can be closer together. Often, one assembly may contain several variable capacitors all operated from the same shaft, but for use in different parts of a circuit. These are generally called 'ganged' capacitors.

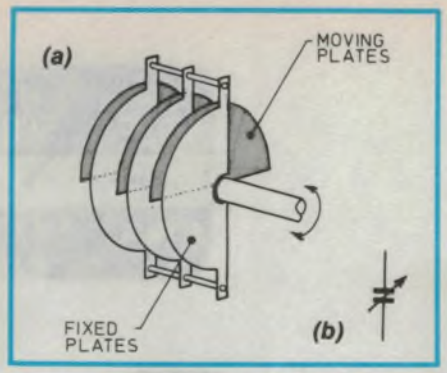


Fig.3: A variable capacitor such as that used in a radio is constructed as depicted in (a). Normally an insulating washer, made of plastic is interleaved between the plates, giving a much smaller construction compared to one with air as the dielectric. The symbol of a variable capacitor is shown in (b).

Another type of variable capacitor is the *trimmer* capacitor, which is adjustable with a screwdriver. The construction of one type of trimmer is shown in Fig.4, in which one plate is a layer of metal oxide on the ceramic body of the unit, and the variable plate, separated with a Mylar washer attaches to the adjustable shaft.

Most variable capacitors have a relatively small value of maximum capacitance, typically around 10pF to 100pF, and the adjustable vanes are usually connected to the common (or earth) line of the circuit.

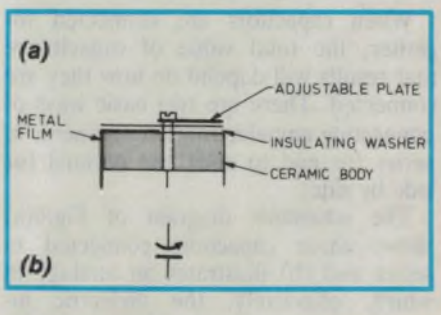
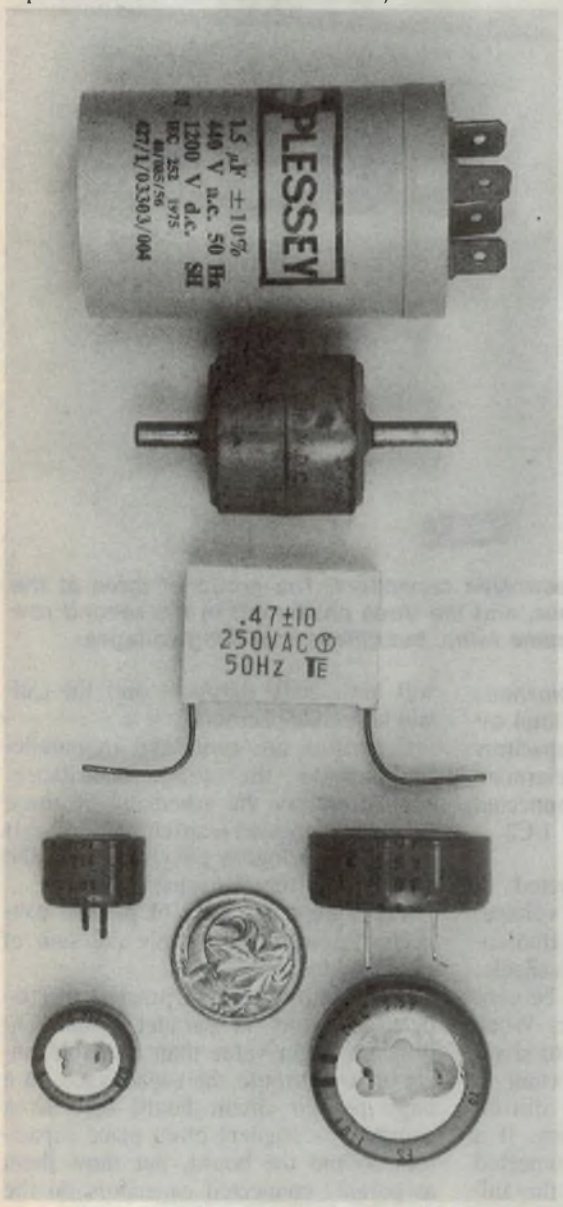


Fig.4: A trimmer capacitor requires adjustment with a screwdriver, and most are designed to mount directly onto a PCB. The construction of a typical trimmer capacitor is shown in (a), and the symbol is shown in (b).



Capacitors come in a range of styles, such as those shown in this photo. The capacitor at the top is designed for use with a mains appliance, such as a motor, and the one beneath it has a rating of 20kV. The capacitors grouped next to the 2 cent piece are all 'super caps'. The capacitor on the right has a capacitance of 1 farad, with a working voltage of 5.5V.

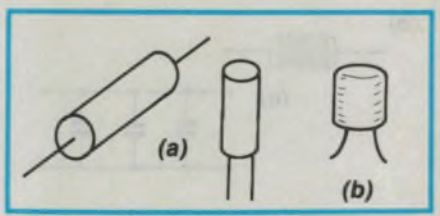


Fig.5: Capacitor packages are usually the axial style as shown in (a) or the PCB mount type depicted in (b).

Package styles

Capacitors are available in several package styles, but the two most common are the *axial* lead type and the *PCB mount* type, depicted in Fig.5. Another type is the can type, which may contain several individual capacitors all sharing a common terminal. There are other less common types, such as those designed to fit under an IC, and special

high voltage types.

Most capacitors have the capacitance value marked on the case, although Philips and other makers sometimes use a colour code. Capacitor values generally follow the same set of preferred values that apply to resistors, in which multiples of 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8 and 8.2 are used. Thus it is common to find a 0.56uF capacitor, but uncommon to find a 0.5uF value.

Some manufacturers label the value in picofarads, assigning a numerical value for the number of zeros. For example, a capacitor whose value code is 104 is equal to 100,000pF (10 with with four zeros). To convert this value to uF, move the decimal point back six places, giving 0.1uF. Similarly, the value 563 decodes to 0.056uF, or 56nF.

Combining capacitors

When capacitors are connected together, the total value of capacitance that results will depend on how they are connected. There are two basic ways of connecting any electronic component: in series (or end to end) and parallel (or side by side).

The schematic diagram of Fig.6(a) shows three capacitors connected in series and (b) illustrates an analogy in which, effectively, the dielectric increases in thickness. Because the dielectric is 'thicker', the overall capacitance of the combination is now *less than the smallest single value in the combination*.

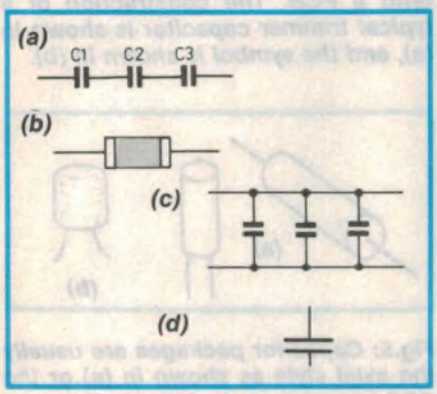
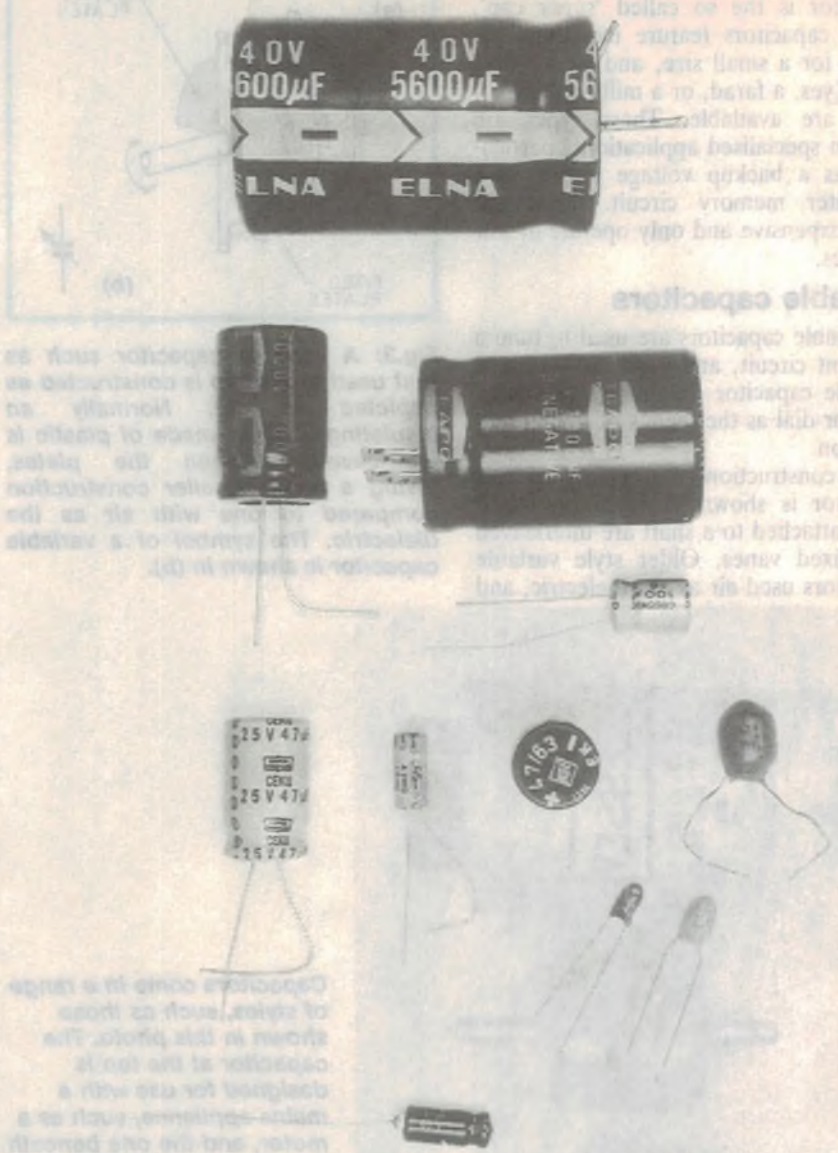


Fig.6: (a) shows the schematic diagram of three capacitors connected in series. The effect is to increase the thickness of the dielectric, as illustrated in (b). This gives a smaller total capacitance, but a higher overall working voltage. Connecting capacitors in parallel (c) has the effect of increasing the total plate area as in (d), resulting in a total capacitance that equals the sum of the individual values.



This photo shows various electrolytic capacitors. The group of three at the bottom right are tantalum types, and the three on the left in the second row from the bottom all have the same value, but different working voltages.

The equation to calculate the total capacitance of series connected capacitors is identical to that used to determine the total resistance of *parallel* connected resistors, and equals 1/(1/C1 + 1/C2 + 1/C3 ...).

Capacitors are often connected in series to give a higher working voltage. For example, if a 1uF, 600V rated capacitor is required but is unavailable, three 3uF, 200V capacitors can be connected in series as a substitute. When connecting capacitors in series to share the working voltage, it is important to realise that the voltage will be distributed inversely to the capacitance. If a 1uF and a 2uF capacitor are connected in series across a 300V supply, the 1uF will have 200V across it and the 2uF will have 100V across it.

Capacitors are connected in parallel to increase the total capacitance. Fig.6(c) shows the schematic of three parallel connected capacitors, and (d) shows an analogous effect in which the total area of the plates has increased.

The total capacitance of parallel connected capacitors is simply the sum of the individual values.

It is a fairly common practice to connect capacitors in parallel, usually to obtain a larger value than available singly or to *distribute* the capacitance. In a large printed circuit board such as a computer, designers often place capacitors around the board, but show them as parallel connected capacitors on the

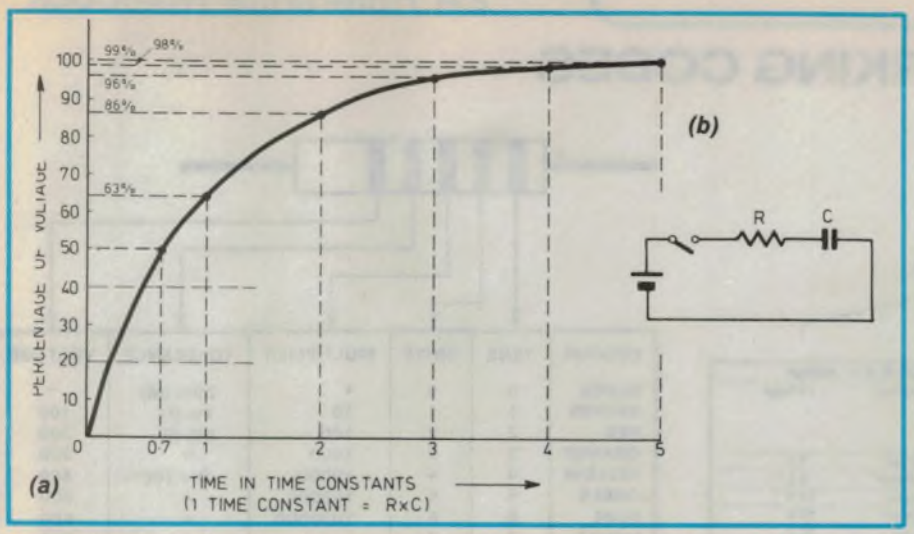


Fig.7: (a) shows the universal time constant curve for an RC circuit, and (b) the circui that applies to this curve. A similar curve, but drawn upside down from top left to bottom right) is used to describe how a capacitor discharges through a resistor.

circuit diagram. For example, if four 0.1uF capacitors are shown in parallel on the circuit diagram, you might think that one, 0.4uF capacitor would do instead. But no! On the printed circuit board, the four capacitors will be spaced around the board. This is done because the PCB tracks have inductance, (inductance was discussed in the last chapter), and by physically spacing the capacitors this prevents the inductance of the tracks from affecting operation.

Capacitors can also be connected in series/parallel, to give a combination of increased capacitance and working voltage. A point to always watch when connecting electrolytic capacitors is the polarity of the individual capacitors. In series, the positive terminal of one connects to the negative of the next, while in parallel the positives are all connected together and the same with the negatives.

Now that we have discussed capacitors fully, let's put them to use in a simple timing circuit.

The RC circuit

A common use for a capacitor is to provide a time delay. In fact, most timing circuits use a capacitor in conjunction with a resistor. To explain the principle, we need to introduce a new term, called a *time constant*.

When a capacitor is charged via a resistor, as shown in Fig.7(b), the voltage across the capacitor will rise as shown by the graph in (a). This graph is a most important representation, as it describes all resistive/capacitive (RC) circuits. Note that it does not include the individual values of the components used in the circuit. This graph is referred to as the *universal time constant curve* and is calibrated in percent of final voltage (vertical axis) and in *time constants* along the horizontal axis.

A time constant is defined as the *time taken for a capacitor in a series connected RC circuit to charge to 63% of the applied voltage.* It is calculated by simply multiplying the individual values of the resistor and the capacitor. That is, TC = RC – an easy one to remember. For example, if a resistor of 100k ohms is connected in series with a 0.1uF capacitor, the time constant of the circuit equals 100k times 0.1uF. This calculates to 0.01 seconds, or 10 milliseconds.

If a voltage of 10V is applied to the circuit of Fig.7(b), then for the values just stated, it will take exactly 10 milliseconds for the voltage across the capacitor to reach 6.3V. This is shown on the time constant curve, where one time constant intersects with the value of 63% of the final voltage.

If you study the curve, you will see that it takes two time constants for the voltage to reach 86%, and that after five time constants, the voltage across the capacitor is virtually equal to the applied voltage. Theoretically, the capacitor will never charge to the applied

TABLE 1: SUMMARY OF EQUATIONS FOR CAPACITORS

Capacitors in series: $C_T = \dfrac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots}$

or for two capacitors: $C_T = \dfrac{C_1 \times C_2}{C_1 + C_2}$

for N capacitors of the same value (C) in series:

$C_T = \dfrac{C}{N}$

Capacitors in parallel: $C_T = C_1 + C_2 + C_3 + \ldots$

Charge in a capacitor: $Q = CV$

where: Q = charge in coulombs
C = capacitance in farads
V = voltage in volts

Capacitive reactance: $X_C = \dfrac{1}{2\pi fC}$

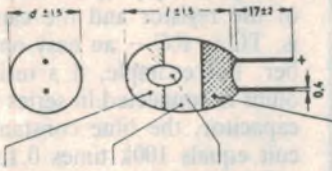
where: X_C = capacitive reactance in ohms
f = frequency in Hz
C = capacitance in farads

Time constant: $TC = R \times C$

where TC = time constant in seconds
R = resistance in ohms
C = capacitance in farads

CAPACITOR MARKING CODES

Solid Tantalum colour coding



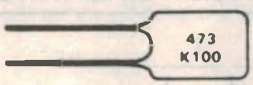
Capacity in µF				Rated d.c. voltage	
Colour	Dome 1 digit	Ring 2 digit	Dot multiplier marking of polarity	Colour	Voltage
black	–	0	x 1	white	3 V
brown	1	1	x 10	yellow	6,3 V
red	2	2	x 100	black	10 V
orange	3	3	–	green	16 V
yellow	4	4	–	blue	20 V
green	5	5	–	grey	25 V
blue	6	6	–	pink	35 V
violet	7	7	–		
grey	8	8	x 0,01		
white	9	9	x 0,1		

Marking of capacity: colour dot indicates the polarity orientation according to drawing.

Reproduced from the ITT Components data sheet for "TAG" capacitors, courtesy Standard Telephones & Cables Ltd

IEC marking code

Miniature ceramic capacitors and small polyester film capacitors are often marked according to the IEC marking code, where space would not permit the value in pF and other data to be given in full. Briefly, the IEC code is as follows. The first and second digits are the first and

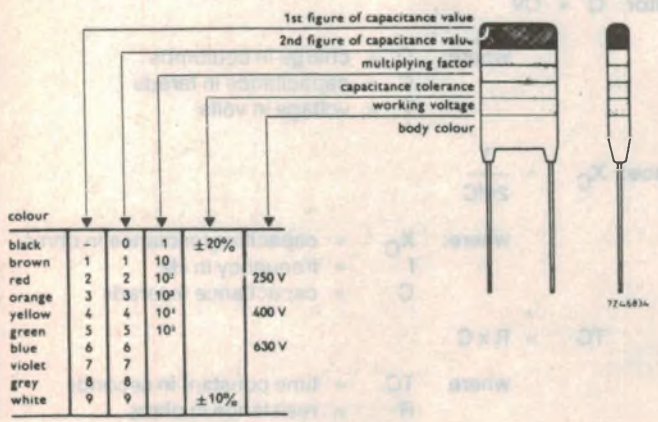


second significant figures of the value in pF, while the third digit is the multiplier in terms of powers of 10. Any alphabetic letters following indicate tolerance, i.e., M is 20%, K is 10%, J is 5%, C is +/– 0.25pF. Further figures indicate working voltage.

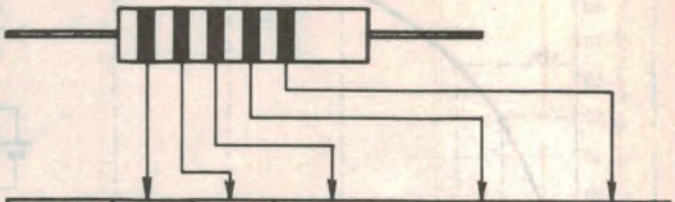
Temperature coefficient

Miniature ceramic capacitors are manufactured with various temperature coefficients of capacitance—i.e., they exhibit different degrees of capacitance change with temperature. Type N750 (violet colour code) has 750ppm°C negative coefficient; type NPO (black colour code) has less than 30ppm°C, either polarity. These are the two most common types.

Metallised Polycarbonate colour code



The drawings above and to the right are reproduced by courtesy of Elcoma. (Philips Industries Ltd.)

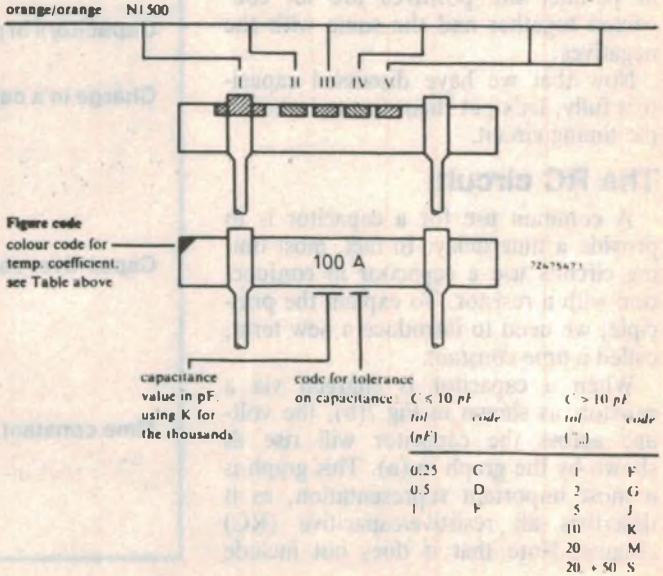


COLOUR	TENS	UNITS	MULTIPLIER	TOLERANCE	VOLTAGE
BLACK	0	0	1	20% (M)	–
BROWN	1	1	10	1% (F)	100
RED	2	2	100	2% (G)	200
ORANGE	3	3	1000	–	300
YELLOW	4	4	10000	-0 +100%	400
GREEN	5	5	100000	–	500
BLUE	6	6	1000000	–	600
VIOLET	7	7	–	–	700
GREY	8	8	–	–	800
WHITE	9	9	–	–	900
GOLD	–	–	0.1	5% (J)	1000
SILVER	–	–	0.01	10% (K)	2000

The international colour code is used to indicate the value and other characteristics of resistors, capacitors, and other components. Various arrangements, differing slightly from that shown, are used by individual manufacturers. (The letters in the tolerance column are sometimes used in place of colours.) Resistance values are in ohms and, unless otherwise specified, capacitor values in pF. As indicated in the ceramic code (below) the tolerance on capacitance values equal to or less than 10pF are often quoted in pF rather than percentage. Values greater than 10pF are quoted in percentage.

Ceramic colour code

	temperature coefficient	*first digit*	*second digit*	*multiplier for the capacitance*	*tolerance on capacitance* $C \leq 10$ pF (pF)	$C > 10$ pF (%)
red/violet	P100					
black	NP0		0	1		±20
brown	N033	1	1	10	±0.1	±1
red	N075	2	2	10^2	±0.25	±2
orange	N150	3	3	10^3		
yellow	N220	4	4	10^4		
green	N330	5	5		±0.5	±5
blue	N470	6	6			
violet	N750	7	7			
grey		8	8	10^{-2}		
white		9	9	10^{-1}	±1	±10
orange/orange	N1500					



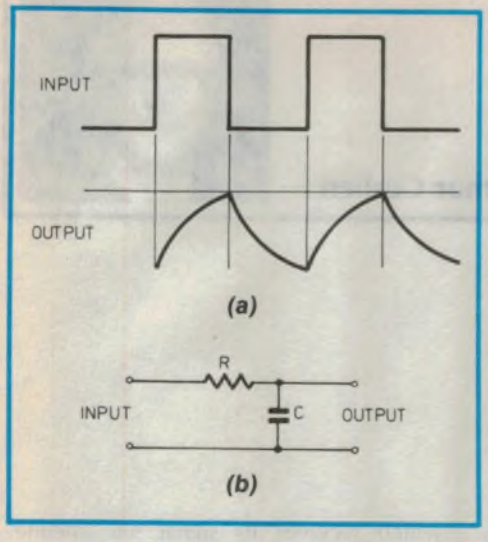


Fig.8: An RC circuit such as that shown in (b) can be used to change the shape (and the sound) of a formwave, as in (1). Note how the waveform is rounded with a shape following that of the time constant curve in Fig.7.

voltage, but we can regard 99% as close enough. In fact, you can use this curve to determine the voltage across the capacitor for any time interval. For example, after 0.7 time constants (i.e., 7 milliseconds for our example) the capacitor will be charged to half the applied voltage.

Now let's say you want a circuit that gives a delay of one second.

Using the equation of TC = RC you can see that there are an infinite number of values that will give a time constant of one second. If we pick a resistor of 1 megohm, then a capacitor of 1uF will give the required time constant of one second. If we apply 10V to this circuit, it will now take one second before the voltage across the capacitor has reached 6.3V.

To make a timer, all that is now needed is a circuit that *triggers* when the input voltage reaches 6.3V.

In future chapters we will show how this can be achieved, but now you know the basic principle of a timing circuit.

Another use of an RC circuit is to modify a waveform. Most sound systems have a bass and treble control, and the actual controls are usually variable resistors in conjunction with capacitors. The circuit is often quite complex, although the basic circuit of Fig.8(b) will act as a treble cut (or bass boost) control.

The waveforms shown in Fig.8(a) illustrate how a square wave is affected by the circuit of (b).

Note how the output waveform has a shape like that of the time constant curve, but one that charges and then discharges for each half of the input cycle.

The effect is that the sound will be smoother, with the high frequencies removed, much like operating a treble cut control on an amplifier.

In conclusion

Over the last six chapters we have examined the three fundamental electrical quantities of voltage, current and resistance.

As well, the three main passive components used in electronics (resistor, inductor and capacitor) have been described, along with some basic maths that describe their behavious.

A summary of all the equations we have described that involve capacitors is shown in Table 1.

Next month we will examine the diode and start looking at some actual electronic circuits that you can actually build.

SHORTWAVE LISTENING

by Arthur Cushen

Greenwich discontinues time service to BBC

For 75 years, the Greenwich Observatory has provided the world with time pips, but the BBC has now taken over the function of providing a world time service.

The change took place recently, when the pips were transmitted from the basement of the BBC's Broadcasting House in London rather than being relayed to the radio over landlines from the Royal Greenwich Observatory in Herstmonceux, southern England. The new signal is accurate to within one millisecond compared to a five millisecond delay in the old pips, which had to travel along 160km of landline.

The BBC is basing its time on a combination of sources, following a decision by the Royal Greenwich Observatory that astronomy and the measurement of the earth's rotation is no longer part of its work. In the basement of Broadcasting House, four clocks are linked by radio and satellite to international atomic time standards.

For listeners to the World Service of the BBC, there is a problem. Checks have shown that time pips transmitted direct from London are received a split second before those which are carried by a BBC transmitter at a relay base, which receives its signal via satellite. The time difference arises because the signal has to travel up to the satellite and back down to the relay base. Anyone who has made an international telephone call will be aware of satellite links and the problem of conversation when there is an echo effect.

An accurate time system at the transmitting site is planned so that when listeners listen to the Singapore relay base of the BBC, time pips will originate from that site and not from London. BBC engineers are also looking at using a telephone line to the remote relay bases overseas, which would compensate for the time delay between them and London.

The BBC plans to keep its time pips as accurate as those of the Royal Greenwich Observatory – at least within one millisecond.

AROUND THE WORLD

ALASKA: KNLS' schedule has been reduced to 10 hours a day, to allow for upgrading of equipment and the introduction of automation. This reduced English schedule, effective for several months, is 0800-0900 and 1500-1600 on 11715kHz. English is not broadcast on Monday 1500-1600UTC, being replaced by Asian languages.

BELGIUM: BRT Brussels has retimed its service to Australia and now carries English 0630-0700 on 6035, 11695 and 13675kHz; the service to North America is 2330-2400 on 11695 and 13675kHz.

HOLLAND: Radio Nederland now broadcasts in English to Australia and New Zealand 0730-0825 on 9630 and 9715kHz, the latter replacing 15560kHz. The broadcast from 1030-1125 remains on 11890kHz. In the Thursday transmission the feature programme is 'Media Network', an electronic magazine for the shortwave listener.

SAN MARINO: A new country for shortwave listeners is projected, with the move by Adventist World Radio from their present Forli site in Italy to San Marino. The new facility will replace the existing lease-term arrangements from Radio Trans Europe in Portugal, as well as the church-owned 5kW shortwave station at Forli in Italy. It will complement the coverage of AWR Asia from a 40 hectare site, with studios in San Marino. Two shortwave transmitters are proposed, of 100kW and 250kW. The first stage of the project will include building four antennas, consisting of three log-periodic antennas and one curtain array. A further curtain antenna is planned. Initially one transmitter will drive any of the log-periodic antennas, and up to three more transmitters could be added when funds become available. It is expected that the new station will be operational within two years.

SWEDEN: Radio Sweden is to reduce its language broadcasts, particularly in French, Spanish and Portuguese, and increase transmissions to Eastern Europe. Priority is to be given to the Russian, German and English broadcasts which will have more resources and personnel. Radio Sweden has made some changes in its transmissions to Australia and New Zealand; English is now broadcast 1130-1200UTC on 17740, 21570 and 21610kHz, with a later transmission 1400-1430 on 17740 and 21610kHz. A broadcast 0230-0300 is now on 11705 and 15295kHz and this programme includes 'Sweden Calling DXers' on Wednesday.

Headquarters of the Red Cross Broadcasting Service in Geneva, Switzerland.

Red Cross tests

The International Committee of the Red Cross in Geneva, Switzerland, is to conduct another series of tests using the facilities of the Swiss Broadcasting Corporation. The ICRC began broadcasting during the final days of World War II, when they transmitted lists of prisoners awaiting repatriation, and of missing people.

In 1948, the ICRC was granted the use of a frequency in time of major crisis, and began test transmissions. It uses a recording studio and broadcasting facilities in Geneva which are given free of charge by the Swiss PTT and Swiss Radio International.

The programmes are in English, French, German, Spanish, Portuguese and Arabic and contain news of Red Cross action around the world.

The Red Cross Broadcasting Service has listeners in every continent and welcomes reports, comments and questions to 19 Avenue De La Paix, Geneva, Switzerland. An IRC is appreciated, and reports and confirmed by QSL cards.

The International Red Cross test broadcasts were scheduled for Mondays, June 25, July 30, August 27, and for Thursdays, June 28, August 2 and August 30, at 0740-0757UTC on 9560, 13685, 17670 and 21695kHz.

This column is contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand, who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT), which is 10 hours behind Australian Eastern Standard Time.

The Serviceman

Enough! Enough! He cried – at least until the morrow...

Readers have responded well to our appeal for contributions. I now have enough material for several months of 'Serviceman' stories, to supplement those from my own workshop. I have four items from contributors for you this month, in fact – three stories, plus a rather amusing ditty that should strike a few familiar chords.

The first two tales come from the same reader, L.D. of Elizabeth in South Australia. Both stories are linked by a common theme, so I'll let L.D. tell the story in his own words:

Sometimes it appears that if you know the difference between a resistor and a capacitor, you can get the reputation of being an electronics whizz and this can drop you into some seemingly awkward situations. ESPECIALLY so if an acquaintance asks you to "Please, just have a look at it for me, and give your opinion."

Two such incidents occurred a few months ago and rather than stumping me, as I feared they might from the initial stories, they actually enhanced my 'electronic whiz' reputation.

The first was when a friend brought in what looked like a car distributor, with the complaint that "the motor wouldn't go". I knew that he was reasonably good at repairing cars and was surprised that he would ask me about a distributor – until he opened it.

Rather than being the 'old' familiar system of breaker points etc., it had an optical disc which interrupted the light from an IR LED to a photodetector – which in turn was connected to a circuit board with three or four transistors, an IC and a few other discrete components. What these components were was not obvious, as the board was potted in what looked like a solid lump of shellac, with the components barely visible inside.

I was reluctant to even attempt to look at it, knowing how awkward it is to get at potted circuits, but after hearing his story, I decided to have a quick look – at his risk.

Basically, the story was that the car engine would sometimes refuse to operate, and he had traced the trouble to the distributor by the simple expedient of borrowing a good one from a friend's car. The big problem came when he tried to buy a new circuit card or a replacement unit. New circuit boards were not available; it was either a complete new unit or nothing, and a new unit would cost him $600 plus!

He was able to supply me with a circuit diagram, made in the usual motor manual fashion of 'connect the red wire with the white stripe to the terminal marked B'. This was not a lot of help, but he had traced which wire was the chassis connection and which was the +12V lead – so at least I had a starting point.

Another four wires went to a black box in the engine compartment. I had no idea what this black box did, but I reasoned that the unit in hand must send some pulses to it. And as the distributor was either operating properly or not at all, then if I could detect any pulses coming from it they would probably be the right ones.

The story on the intermittent operation was another problem, but after discussing it we decided that it was probably heat sensitive: if parked for a few hours in the shade the car would start and run – for a short time on a hot day, and longer on a cool one.

A quick check with the CRO showed that the unit would give out pulses on all four leads when +12V and earth were connected and the shaft rotated. But as I do not have a four-trace CRO, I could tell nothing about the phase relationship of these pulses. It could be done, laboriously, with the dual-trace CRO and I mentally worked out how to do that later, if necessary.

The next step was to check for sensitivity to heat. This was easy. I simply used a hot air gun to heat the unit, while retesting it (holding it in rag this time to avoid burning my hands!)

Success! Not a pulse on any line! After allowing it to cool again it worked as it had initially.

The next problem was more perplexing – how to get through the potting to find the faulty component? I was able to cut off some small pieces, as it was rubbery rather than solid, and tried various solvents on them.

Luckily, a rather safe solvent, methylated spirit, did the trick so I left the circuit board soaking in a bath of metho after removing it from the distributor. It took a day before I was able to safely peel and rub off the gunk to see what the components were.

(As an aside, the gunk was not fully dissolved, and after the methylated spirit had dried out it reset. I used this phenomenon later on to replace the potting, to protect the unit for return to service.)

Checking the board after removal from the unit posed a problem, as I could no longer turn the shaft to rotate the optical disc. However, I found I could simulate

the effect by passing a piece of paper through the gap where the disc normally ran.

A combination heat-gun and freezer spray treatment with judicious shielding of components narrowed the problem down to a plastic encapsulated transistor, and I breathed a sigh of relief.

Why relief? Well none of the transistors or the IC had any markings on them! I was relieved that it wasn't the IC, as trying to work out its characteristics and find a replacement would have been a very tedious job.

As I read L.D's story, I found myself getting quite hot under the collar. The first story, about the $600 car part repaired with a 30c transistor, made me as mad as the proverbial meat axe.

It reminded me of the $1200 engine management computer board shown to me by my local service station proprietor recently. The board contained no more than $20 worth of parts, but could not be repaired because all part numbers had been removed by the manufacturer. And of course, there was no circuit diagram or service manual.

New cars are getting more and more expensive, so that only the well-to-do can afford them. And the less wealthy will be denied useful second-hand vehicles, because of the exorbitant prices demanded for replacement electronics.

Doesn't it seem stupid, that at a time when electronic products are getting cheaper every day, automotive electronics are getting more expensive – and being deliberately designed to prevent easy servicing!

Then L.D.'s second story, about the 'white thingummy' is just as disheartening. Luckily, this customer knew enough and had the gumption to take the argument right back to the retailer. How many other customers would have simply shrugged, bought a new $350 controller and silently cursed the manufacturer instead of the retailer?

Flipping pic

Anyway, now on to the third story for this month. It comes from S.McB. of Townsville in Queensland, who reminds us that the practise of electronics can involve all sorts of disciplines – but rarely does the service technician need a knowledge of *optics* to solve his problems. Read on, for a short lesson in photography as well as electronics servicing...

It seems that S.McB. has a customer who complained that the picture on his 'TV' kept turning itself 'upside down'. One minute the people were right side up, next minute they were standing on their heads.

Now, it's possible to make a picture turn upside down. All that is necessary is to reverse the leads to the vertical winding on the yoke. This will invert the picture, but will not alter the left-to-right orientation.

To change up-down AND left-right, the leads to both horizontal and vertical yoke windings have to be reversed. Quite clearly, this is not something that can happen spontaneously!

The customer was asked to bring in the television set so that it could be tested thoroughly. It turned out to be not a 'television set' at all, but a video monitor – a professional grade monochrome monitor from a CCTV system.

On the bench, hooked up to a good video camera, the monitor produced a first class picture with no sign of any instability, either horizontal or vertical.

This seemed to point to the CCTV camera as the culprit in the case. In due course it was delivered to the workshop and connected to the monitor, in the same configuration as in the customer's premises.

The camera was soon confirmed as the villain, when the picture started flipping over top to bottom. What's more, it was also flipping side to side. In other words, a complete 180° rotation.

As mentioned, there's no easy way to achieve this rotation. And there's no conceivable way it could happen by accident. At least, not with any conventional camera and monitor setup. But this camera was not *quite* conventional – at least among cameras common up to the present time. It's likely to become the conventional model from now on, as you will see.

The CCTV camera was not a vidicon tube type, but one of the latest CCD-sensor solid state cameras. And its output was not the usual analog signal produced by scanning the target with an electron beam guided by scanning coils. It was a pseudo-digital signal, clocked out of the CCD sensor array by digital type shift registers.

(I have read eight different explanations of how the output of a CCD chip is produced and really, I am none the wiser. In precise detail, it is a very complicated process. It's best to simply accept that an IC controls the CCD and the output is composite video!)

In the problem facing S.McB., it seemed that the shift registers were running forward one minute, then backward the next – clearly a ridiculous idea. But there was no other explanation!

In the end it was a chance observation that provided the clue that solved the problem.

The camera was dis-embowelled and spread out, still operating, on the bench. Discrete prodding and poking revealed that the fault was mechanical, and responded to pressure near a particular jumper wire adjacent to the control IC.

Reference to the circuit diagram showed this jumper to be connected to a pin on the IC marked 'lens', and further reference to the service manual resolved the whole dilemma.

The manual explained that the Lens pin should be grounded for use with a 'normal' lens, or open for a 'terrestrial' lens. With this, all became clear!

Most camera lenses produce an inverted image on the film (or vidicon or CCD). This is normal and has been taken for granted by photographers for about 150 years. (I spent some years as a photographer, and in those days I would have given anything for a switch that could erect the image on the groundglass of my studio camera!)

In the same way, astronomers have always accepted that their telescopic images of the heavens have to be inverted to make them agree with naked eye sightings.

On the other hand, birdwatchers and yachtsmen would not accept an inverted image. Terrestrial telescopes and binoculars have to have an erecting lens included in their construction, to allow the user to see things 'right way up'. Some camera lenses have also been made with this erecting lens built in, to enable the lens to function as either a camera lens or a telescope.

In a normal film camera, it doesn't matter which way up the image lies. If a terrestrial lens records a picture upside down, the final print can easily be turned up the other way.

So that was the function of the jumper in the camera before S.McB. It was intended to invert the image if the camera was fitted with an erecting lens. Quite simply, the jumper lead had become dry jointed, and was flipping the shift register between the upright and inverted modes.

To our knowledge, this provision (for inverting the image) has never been made on a video camera before, hence the hours of confusion that led up the solving of the problem.

S.McB. gave me this story as an aside, while discussing another matter. I've repeated it here to alert readers to the fact that you really have to be the full bottle on all manner of subjects, to stay ahead of modern electronics!

At least the transistors were obviously simple switches, being connected between the +12V rail and ground – with the bases fed from the IC and the outputs going to the output terminals where I had measured the pulses.

Finding a replacement was not hard. The collector resistor value indicated a maximum current of about 15mA through the transistor, so I chose a BC548 and wired it in place. Then I tested the unit for heat sensitivity. With the problem now seemingly solved, I replaced the potting compound, assembled the unit, tested and returned it to the owner.

As I said, that was several months ago, and the car has been running without missing a beat since then; so I can chalk that one up as solved.

The second case followed about a month later, and although there was nothing technically difficult about this one either, it also involved saving considerable money for the customer.

(It is nice to have really grateful customers who are willing and even anxious to pay more than the job is worth, just because you were able to do something for them that they had thought impossible.)

This case concerned an automatic home watering system, installed about four years previously. It belonged to a very capable and enthusiastic lady gardener, and had been working perfectly until about three weeks before she saw me.

It was summer and she was going away for a few weeks holiday. Naturally, she did not want her lawns and garden to suffer during her absence, but the sprinkler controller had blown a fuse.

She looked at the blown fuse and bought a replacement, but although the replacement fuse did not blow, the unit started issuing smoke and a white 'thingummy' had turned black.

She called in the expert (salesman?) from the company which had installed the system, and after looking at it he told her that the 'thingummy' was a special integrated circuit, no longer available, and that she would have to get a new unit. This was, of course, an updated version and would cost $350.

As her holiday budget was fully committed, she could not spare $350 just at that time. She was in a quandary, and came to me asking "would I please have a quick look at it, to see if something could be jury-rigged to keep it going for a while?"

I imagined that the 'white thingummy' was one of those welded-in ceramic IC's, and I expressed some doubts about the possibility of making a repair. But eventually I agreed to give my opinion.

The next day she arrived with the unit. This was a rather fancy box, with a liquid crystal display and push buttons to set just about everything except the excess water bill. She opened the bottom of the case, which comes off to gain access to the terminals, and pointed to the 'IC'.

I recognised it immediately as a 5 watt resistor! Luckily it was not black, but just badly burned and I could read the value as 4.7 ohms. (It also measured 4.7 ohms on the meter, but I later replaced it as it had obviously been badly overheated.)

I then checked out the timer and found that it was sending 24V to the correct output terminals at the right times, and in fact seemed to be working perfectly.

The burnt resistor had me worried though, so I traced the circuit involving it. It was connected in series with the common output terminal, acting as a current limiter while the other terminals were connected to drive transistors.

On a hunch, I checked the fuse. 10 amps? 4.7 ohms by 5 watts gives one amp! When I asked her about this, she went a little red in the face and replied that the blown fuse had a 10 on it and she hadn't looked for a decimal point!

(In fairness to the lady though, despite the fact that she repairs her own electrical appliances and also makes many mechanical repairs to other items, she generally avoids electronics as 'too complex', and had never encountered fuses as small as one amp.)

This suggested a likely answer to the problem. I asked her to check the resistance of the solenoids which turn the water on and off. She has her own multimeter and is quite capable of using it.

Next day she reported that one was reading about 2 ohms while the others were all nearer 200. She had disconnected the faulty solenoid and the system was now working, with all but one spray point. After returning from holidays she replaced the faulty solenoid valve and the system was fully operational again.

As a matter of interest, she can be a very hard lady to deal with, especially if anyone is not honest with her, and she proved it again in this case.

She had been charged a 'service fee' by the company for the initial call-out and had paid it. But after replacing the unit and finding it to be working, she went to see the manager and not only got her service fee refunded but also demanded, and got, a replacement solenoid valve to compensate her for the trouble that they had caused her.

Technically, neither of these cases required any particular genius, but both were items that I had never encountered before. In addition, both of the problems came to me as a 'last resort' after all the normal avenues had been explored.

In retrospect, the faults and diagnostic methods were much the same as for any

radio or TV set. More importantly, it was the clues provided by talking with the customer which really solved the problems in both cases.

Electronic muse

And finally, a bit of poetry to lighten the tone of this month's column. It was contributed by L.F., of Woodville Gardens S.A., and although it's a bit out of our usual style, it seemed just too good to keep to ourselves. L.F. calls it:

LIFE IN THE DAY OF A SERVICEMAN!

Who was the clever person
who said you never can
'Please all the people all the time'
– was he a Service man?

Years in the industry have proved
that statement to be true.
I wonder if the scenes to come
strike a similar chord in you.

A customer comes in and plonks
his set up on the bench.
"It's never been no good" he says
– in English laced with French.

'I could 'ave fixed it up meself,
but I've no time at present.'
You weakly smile and nod your head,
and try hard to be pleasant.

Then when it's fixed he must donate
a little of his wealth.
"WHAT? 60 bucks to change a part
I could've changed meself?"

But what's the use of trying to
explain the hours it took
to find the leaky diode, when
he KNOWS that you're a crook?

The phone rings half a dozen times,
you think you'll go insane,
from video enquiries you're
expected to explain.

"I think I've got it now, but could
you tell me just once more –
what is that button labelled
'video-antenna' for?"

Then there's the set that must be fixed
with lightning haste and speed.
The customer puts on an act
that makes your poor heart bleed.

You push it through in record time
because you feel you must.
It's been repaired for six weeks now,
and sits collecting dust...

Another chap comes in with
a CB, wet and salty.
He's not sure why it doesn't work
but says "– I think it's faulty!"

Then adds this gem to just make sure
his story you believe:
"I'm not sure if it won't transmit,
or if it won't receive!"

That repair you really should've dumped
again lands at your door.
The customer is all upset,
starts laying down the law.

"You've scratched a leg, mislaid a knob,
and knocked a plastic trim".
"The picture's now too bright!" he adds,
– you can't say that of him!

A lady brings a Walkman in and asks
"Please can you fix it?"
You get the feeling that her son
occasionally kicks it.

The lid is broken, cabinet's cracked,
the headphones are in tatters,
but fixing up his pride and joy
to her is all that matters.

A worried lady then rings in,
with a voice that's very faint.
It seems she has a microwave
and this is her complaint.

Her food is getting far too hot
and starting to turn brown –
"Would it be right for me to use"
'DEFROST' to cool it down?"

Then there's the chap who loves to tell
that he knows how to solder,
and thinks he's being helpful
looking over your left shoulder.

He also asks a million questions,
trying to make you nervous.
It's all a part of being a tech
when you're on outside service.

But, customers help pay the bills.
What would you do without 'em?

And yes, of course, they're always right.
How could we ever doubt 'em?

They make us prematurely gray,
as well as quicken pulses,
and give us headaches, blood pressure,
and duodenal ulcers.

So in conclusion let me say,
they've all been through our door.
No wonder that a serviceman's
invariably poor!

But if you think these stories are
not true, I ask you then
to notice all the nodding heads –
my fellow service men!

And I nodded along with the rest of them! Thanks L.F., I think we all enjoyed that.

That's all for this month. There are more contributions to come, and some more stories from my own bench. Stay tuned!

Fault of the Month

Sony KV-1830AS
(Early version, before S/N 300.001)

SYMPTOM: No pix until set thoroughly warmed up – about 10 minutes. Luminance could be forced through by raising screen voltage but there was no sign of colour.

CURE: Fault turned out to be an inductor in the collector of the 7.8kHz amplifier transistor, Q309. The coil was open circuit when cold, but came good as it warmed up. (The fault explains the 'no colour', but not the 'no luminance', thus making a very confusing problem.)

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

Has our author developed

The 'ultimate' loudspeaker leads?

In a rare blend of illogicality and commonsensical electronic doubletalk, the author tells a story of one audiophile's foray into the nether world of zero impedance – even negative resistance speaker leads. Read on, and see if you can spot anything wrong with his reasoning...

by BRYAN MAHER

While the editor's not looking, let me tell you about my latest invention, *perfect* loudspeaker leads!

You can forget all that nonsense you have been reading about oxygen-free copper or liquid mercury conductors. They only tried to *reduce* the speaker lead resistance. The fantastic approach described herein does a lot more than that – it reduces the speaker lead resistance right down to zero!

This of course means that the damping factor on speaker cone movement is dramatically increased, so your pride-and-joy speakers will (believe it or not) have even *less* distortion. To the very bones!

You perhaps define damping factor as the speaker impedance divided by the driving impedance. That driving impedance (i.e., the amplifier output impedance plus speaker lead impedance) becomes the damping load, which prevents the speaker cone moving under momentum. Such free wheeling by the cone generates nasty sounds, which you wish would go away – distortions which you need like a hole in the head!

The lower the driving impedance, the more heavily the speaker cone is damped, constraining it like a tempestuous child on a leash and gently persuading the cone to faithfully follow the music signal from your expensive amplifier.

Now the salesman, who gently levered your life savings from you for said amplifier, probably spun a glossy yarn about its low output impedance, waving in the air before your glazed eyes a colourful brochure quoting 'Amplifier output resistance equals 0.002 ohms!'

You recall how you spontaneously jumped for joy, scaring the devil out of your sultry spouse as you mentally calculated a speaker damping factor of 8 ohms divided by 0.002 ohms equals 4000! Wow – that's more damping factor than that insufferable next door neighbour, whose damping factor is a mere 400!

So gleefully handing over aforesaid life savings, you rush home with new amplifier under one arm and a fistful of loudspeaker leads gratuitously bestowed upon you as an enticement by the same errant salesman – your doubting spouse and whimpering bairns trailing behind like a string of pearls.

But the sound emerging from your speakers was still distorted as before, with consequent unenthusiastic response from your wiser spouse.

The sad truth

In the still of the night, as you lay counting sheep, the truth suddenly dawned upon your exhausted brain cells.

Of course – the amplifier output resistance (0.002 ohms) is as nothing compared to the resistance of those skinny little copper leads the man so generously threw in for free.

You bound out of bed, oblivious of the crying kids and howling dog you woke in your haste. Must measure those speaker leads! Ripping them unceremoniously from the audio system, your trusty ohm-meter blinks – then tells you that those scrawny leads measure no less than 0.48 ohms!

That in series with the amplifier output resistance is of course 0.482 ohms. So your speaker damping factor is still 8 ohms divided by 0.482 ohms, equalling a very poor value of 16.6. No better than before, in fact.

Dejected, disgusted and muttering agonized comments unprintable in this magazine you stumble off to bed. That salesman!

But no, it's not his fault! There's nothing wrong with the amplifier – you just need speaker leads with zero resistance.

A small voice in the back of your mind keep insisting that *all* connecting wires have *some* resistance. But perhaps there *is* a way...

Super solution

Simple! You just need *superconductive* loudspeaker leads.

No problem – just race down to your nearest hardware store, buy some copper tube plated with niobium-aluminium-germanium alloy. Make up two speaker leads from said exotic tubing, attaching plastic hose to each end as in Fig.1, so you can pump liquid helium continually through the copper tubes. This will cool the niobium-aluminium-germanium alloy down to superconduct-

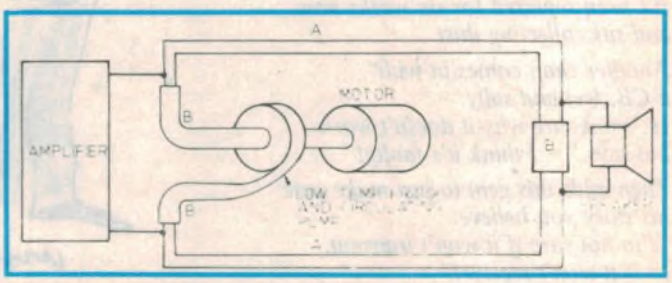


Fig.1: How to use superconducting metal tubing (A) for speaker leads. Tubing B is plastic hose.

ing temperature, below 20 Kelvins (-253°C).

Some of the conduction electrons in the niobium will associate in pairs and short out all the resistance, leaving you with a loudspeaker source resistance of only the amplifier's output resistance, a tiny 0.002 ohms. Hence you will at last achieve a beautifully high damping factor of 4000 as aforesaid!

In eager anticipation, you search through your suburban hardware stores and even undertake a foray into the city. But in no shop can you buy a refrigerator capable of cooling helium gas to such a low temperature. Nor any other gas for that matter! Anyhow, most other gases would solidify before they got that cold.

Desperate, you feverishly scan the newspapers. But instead of ads for super-cold refrigerators, you spy an article about new developments in superconducting ceramics, at temperatures you would call cool, not cold (only about 70K, or – 200°C). Lovely – must buy some!

But these materials are so brittle that they cannot be bent to shape, much less hooked around amplifier terminals...

Defeat! Dejection! Oh woe are you! It is beyond the pale! While you bemoan your misfortune, your other half patiently yearns for better music production.

But all is not lost. You idly pick up a book on electronics, and in its golden pages you learn the fascinating secrets of feedback.

No, not the cheeky feedback you get from your offspring, nor the dry wit of your (usually) supportive spouse.

Magical feedback

We're talking here of *negative* feedback, that wonder of electronics, which can provide for your loudspeaker leads having zero effective resistance. Well – almost. And at ordinary room temperatures, too!

How? Simple – the idea is made clear by the diagram of Fig.3, wherein you may see that negative feedback is taken, not (as you might expect) from the amplifier output terminals, but rather from the loudspeaker terminals. It's called (for want of a better name) 'remote feedback'.

Yes, there still are voltage drops along those loudspeaker leads, but such voltage drops are part of the feedback signal, so are compensated for by the amplifier's open loop gain. Input signal between A and B is amplified by the amplifier's open loop gain to produce amplified voltage and power at C and

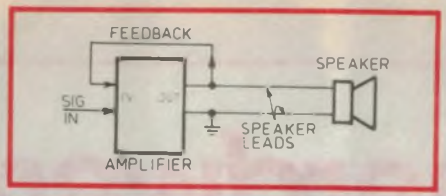


Fig.2: Normal negative feedback is taken from the amplifier's output terminals.

D, in the usual way. But the difference in this circuit lies in the fact that the negative feedback derives from the speaker terminals E and F.

We use ordinary copper speaker leads, with their usual impurities of oxygen, arsenic, sulphur, etc – albeit in microscopically small percentages). The normal resistive voltage drops reduce the feedback signal and as the effective voltage amplified by the open loop gain equals the input minus the feedback, more signal is amplified, effectively compensating for the speaker lead voltage drop. This mechanism causes the very low output impedance (0.002 ohms) of the amplifier to be felt right at the speaker terminals, as if the speaker leads had zero resistance.

Success! The system damping factor returns to 4000 overall! Not only does remote feedback remove the resistance of your speaker leads, it also reduces drastically the inductance effects those leads have on your audio signal. That's even better still!

Admittedly our audiophile had some trouble with his amplifier oscillating under remote feedback (due to speaker lead inductance), but with a little help from generous electronics friends (fiends?), that little problem was unceremoniously conquered.

Better still?

But wouldn't it be nice to be even better still? Lest it be murmured among readers that our friendly (though often misguided) audiophile is greedy, objectionable and socially unacceptable in aspiring to further improvement, let us hasten to recant that wise old adage: 'The world is advanced only by dissatisfied people'.

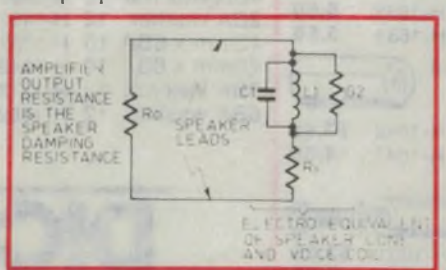


Fig.4: Deriving an equivalent circuit for the amplifier and speaker system.

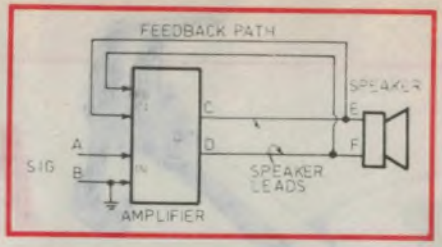


Fig.3: Remote feedback is more effective, although a little tricky.

Let us try to see how that magic damping factor could be improved even more. But how? Consider the fundamental equivalent circuit of Fig.4, showing Ro, the amplifier output resistance which in turn damps the speaker; C1, L1 and G2 the electrical analogs of the speaker's cone mass, inertia, suspension spring constants and stiffness, and R1 the ordinary voice coil electrical resistance.

Observe that Ro and R1 are simply in series, as combined electrical damping. To make even heavier damping we need the resistance value (Ro + R1) to be less. But using Fig.3 we have Ro down to 0.002 ohms, with R1 about 8 ohms. So (Ro + R1) = 8.002 ohms.

How can that value be reduced? We certainly cannot change R1, for that is inside the speaker. Any significant reduction of (Ro + R1) could only be achieved by making Ro negative.

What – you want Ro to be a negative resistance? Crazy! Impossible!

Negative resistance

But wait! It's true that no *physical* resistor can have a negative value, but the marvels of electronic negative feedback can bring about a negative value of output resistance Ro. Yes, it's true!

Fig.5 shows a proposed scheme where Ro is the amplifier output resistance, S1 is the real loudspeaker and S2 is a group of electrical components electromechanically equivalent to the loudspeaker S1. Remote feedback is derived from G and H.

The amplifier thinks it's driving two parallel identical speakers, except that R3 is in series with S2. Now R3 will cause a voltage drop, so that for full signal to appear at the feedback terminals G-H it must be that at full current the signal voltage between E and F is higher than that between G and H. But at no current the voltage E-F is the same as at G-H.

Now just wait a cotton-picking minute! That statement is saying that the voltage E-F *increases*, as current is drawn from the system – not decreases, as you'd expect for a normal system

Continued on page 144

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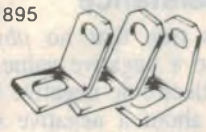

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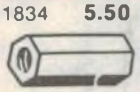

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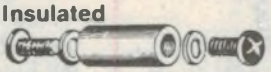

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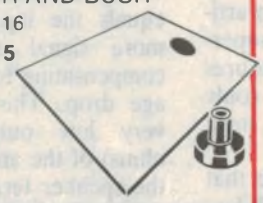

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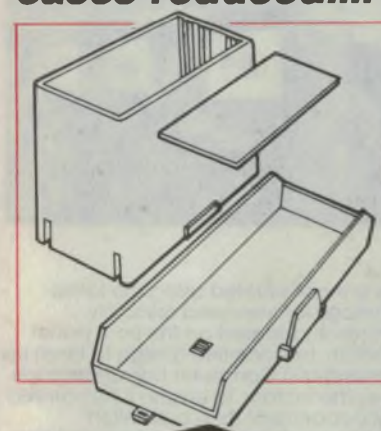

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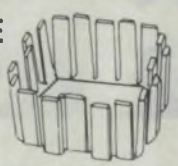

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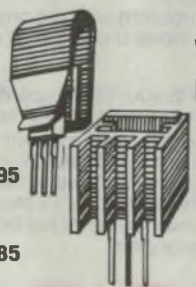

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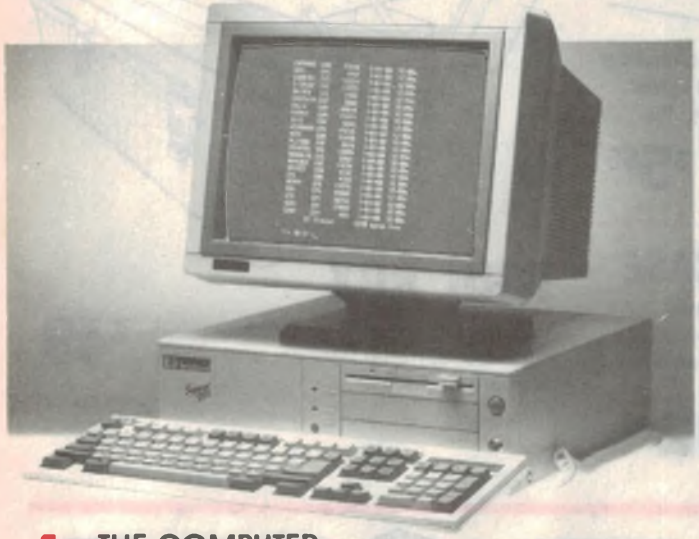

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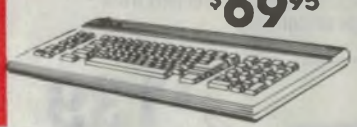

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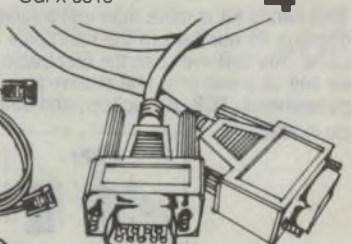

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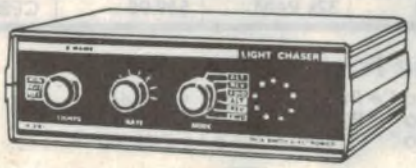

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Automate your light show and let it dance to the music! The Chromavox accepts line input from an amplifier or operates independently, off its built-in microphone. This kit comes complete with a moulded plastic case plus pre-punched silk screened front panel and can handle up to 2400 watts of lighting.

Cat K-3162

$139 EA

Electronic Dice

This handy kit is more than just a random number generator. It displays its numbers in the traditional die format on two rows of three LEDs. You can even see the Electronic Dice counting as numbers roll by and stop just past that elusive six. Short form kit with all components, PCB, IC sockets, and battery holder.

Cat K-3532

$9.95

SILICON CHIP

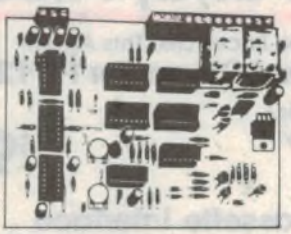
Kits marked with this symbol involve mains power wiring. Take extreme care when working with this equipment.

Degree Of Simplicity — Simple — Intermediate — Detailed

2 Sector Burglar Alarm Control Unit

This Control Unit features variable entry and exit delays, LED status indicators, alarm driver circuitry, timed and latched outputs, two separate sector inputs, and the provision to add extra sector boards as required. This is a short form kit which includes all components, PCB, and IC sockets.

Cat K-8401



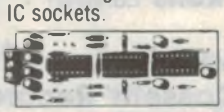
$39.95

SILICON CHIP

2 Sector Module

Expand your K-8401 Burglar Alarm Control Unit. Add as many of these Sector Modules as you need. They hold two sectors, each with LED status indicators and isolating switches. Kit includes components, PCB, and IC sockets.

Cat K-8400



$12.95

SILICON CHIP

Combination Lock

This keypad operated combination lock could be used to operate your K-8401 or other Burglar Alarm. Works with solenoid door locks too! It can even be wired to trigger the alarm when the lock detects repeatedly incorrect entries. The kit includes all components, PCB, and high quality keypad.

Cat K-8403

$29.95

SILICON CHIP

Hot Canaries

Put your budgies out to pasture and let these Hot Canaries rule the roost! Intrigue your cat as these two birds sing their electric sox off. The kit comes with a cat-proof case, PCB, all components, and front panel label.

Cat K-3530

$24.95

SILICON CHIP

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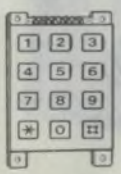
Keypad Matrix Switch



Suitable for electronic locking devices or as numeric input for any digital device.
Cat P-7804 **$3.95**

Neon Bulb

Pigtail type neon bulb as used in indicators, timing circuits, oscillators, etc. 70-90 volts @ 600uA.
Cat P-8160 **75c**

M.E.S. Bulbs

Miniature Edison Screw BULBS to suit most illuminated dials.
Cat P-8150 6 volt
Cat P-8152 12 volt
50c each

M.E.S. bulb sockets
Cat P-8162 **75c**

Car/Battery Clips

Battery Terminal Clip 30A red	P-6420	**$1.25**
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Crocodile Battery Clip 20A red	P-6416	**$1.95**
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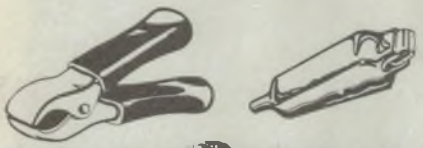
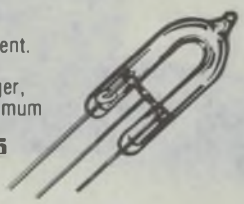


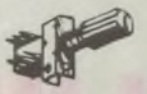
Xenon Flashtube



As used in Strobes, warning lamps, and photographic equipment. Operates on 200-400 volts with a 4kV trigger, and has 5 watts maximum input.
Cat P-8164 **$3.95**

4 Way Switch Pack

This switch pack is ideal for audio switching applications. Each switch is DPDT and mechanically interlocked so that only one button can be activated at once. Switches spaced at 11mm centres.
Cat P-7750 **$5.75**



Single DPDT Switches to match the 4 Way Switch Pack
Cat P-7752 **$1.95**

SPST Lampswitch

The perfect replacement for a worn out desk lamp switch. Fits an 11mm hole and is rated at 240Vac 2A.
Cat P-7874 **$1.95**

DPDT Lampswitch

The double pole version of P-7874. Fits the same hole but has a slightly larger body (23x15x13mm). Rated at 240Vac, 2A per pole.
Cat P-7876 **$2.50**

Illuminated Push Button Switches

A square switch with round body as used in car burglar alarms and control panels. Uses alternate make/break switch action and has an inbuilt 12 volt, 55mA bulb.

Cat P-7580	red	**$13.95 each**
Cat P-7582	blue	
Cat P-7584	green	
Cat P-7586	yellow	

Dashboard Switch

Pull on, push off single pole switch as found controlling lights or wipers in many older vehicles. This switch is ideal for trucks too as it's rated at 24 volts, 10A.
Cat P-7562 **$4.95**

12V Illuminated SPST

Intended for automotive use, the soft glow from the toggle is not distracting. The 12 volt lamp operates from the supply being switched (12 Vdc @ 16A).
Cat P-7666 **$4.25**

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That's right, the Tandy TRS-80 model 3 is definitely NOT a current model. But 'obsolete' models like this can now be picked up quite cheaply, and are fine for many basic computing jobs...

The easy way into computers

As with cameras, new personal computer models seem to appear like clockwork every couple of months. Whatever you buy, within a couple of years it'll be totally 'obsolete'. But just as you can still take prize-winning pictures with an 'obsolete' camera, you can do lots of basic computing jobs – like word processing – with a low cost 'obsolete' computer. In fact they can make an excellent choice for your first machine, or for controlling other equipment...

by TOM MOFFAT

Love them or loathe them, computers are part of life now, and all of us are going to have to learn to live with them. Some people even learn to enjoy them, even though the computer industry seems hell-bent on making computers as hard to get along with as possible. Every day we have piles of hype heaped upon us by television, newspapers, and magazines... "This new Brand-X makes all other technology obsolete! So throw out your old ways of doing things, and buy Brand-X now!"

Why? I mean, why *should* we jump at this 'golden opportunity, too good to miss?' What's wrong with your old computer, or your typewriter for that matter? They work, don't they? If it ain't broke, don't fix it. Here's an example of the pressure we face every day, for 'out with the old, in with the new':

Late last year I attended a computer show; you know, one of those big extravaganzas in which all the swank computer companies send their identically blue-suited and name-tagged salesmen (whoops! sales-persons) to convince you that your business is bound to fail unless you invest in a Brand-X computer RIGHT NOW!

It seems that Brand-X, a well-known multinational company, had chosen this show to unveil its latest mega-machine with the latest 64-bit microprocessor running at some outa-sight clock speed. I had a name tag too, identifying me as

a 'technical writer', and I was humping my big old camera bag around so as to look especially important (the bag can hold several tinnies, as well as the camera). Brand-X's State Salesmanager saw me, and pounced.

"You've gotta do a story on this! Writers all over Australia have been waiting on this one, and here it is, handed to you on a platter!" The man was in full razzle-dazzle mode.

"Well", I said, "what can it do?"

"WHAT CAN IT DO??? Watch this!" And with that he unleashed his machine into a sort of slide show, with high-resolution graphics pictures of sunrises and birds and snow-capped mountains. "That's very pretty", I said, "but I can see sunrises and birds and snow-capped mountains by just stepping out my back door. Why do I need a computer to show them to me?"

"Well, er, um..." (Mission Control, we've got a problem here. This fellow is supposed to fall down on his knees and grovel in front of this computer, and he isn't doing it.) So I hit Mr. Salesmanager with another one: "What does your machine actually DO?"

"Er, aah – it runs Lotus 123".

"So does my old XT" (an 'obsolete' model PC, for the uninitiated).

"But ours is so much faster!"

"So what?"

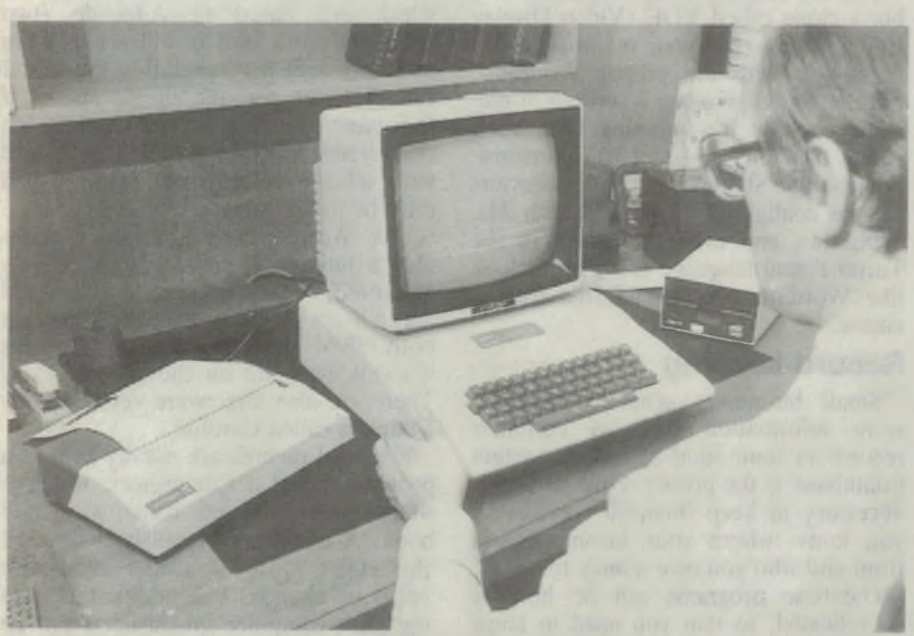
SO WHAT??? You're not supposed to say 'so what' at a computer show. You're supposed to write a glowing report about how this new technology is going to revolutionise the science of computing, etc, etc. You know the stuff; if you've ever read a computer magazine, you've seen it.

So what indeed! But nowadays lots of people are starting to say 'So what' in the face of all the hype, and this troubles the suppliers greatly. Perhaps a simple, cheap computer can do the job as well as the latest rip-snorter model. Many users are finding this to be the case, and some of the most highly touted software packages and operating systems are languishing in a sea of buyer resistance.

The computer industry at long last is starting to get this message, and some portions of it are now catering for the 'so what' buyer who just needs a simple tool to do a straightforward job. So the industry now appears to be heading in two directions: Up, into the world of more power, more speed, more bits, and more money; and sideways or slightly downward into the world of small, simple, and cheap.

The laptop computer is the prime example of this second line of development. The laptop 'revolution' will be the subject of another article, but in the meantime let's look at some other 'so what' options – good practical computing alternatives that will do an honest day's work for you without sending you to the poorhouse or making you tear out your hair in frustration.

If your work is not up in the stratospheric levels of desktop publishing or high-end computer aided design, you probably don't need the flash graphics capabilities of the mega-computers. So something like a simple PC-XT would do, at say a tenth the price. And if you don't need graphics at all, you could lower yourself even further to a (dare I say it..) CP/M computer. Let me explain...



Another 'elderly' personal computer is the Apple IIc, pictured here with disk drive and printer. It too is fine, for many basic jobs.

Main uses

As a reader of *Electronics Australia*, you're probably interested in using computers a bit differently from the traditional 'business' user. There are four main areas where you're likely to use a computer:

1. Word processing; writing letters, business proposals, quotes, etc.
2. Keeping records for a small business, such as a repair shop.
3. Circuit board design.
4. Electronic process control, or pure experimentation.

The fourth item, the computer as part of some electronic device, will be looked at in detail in a separate article. For now let's concentrate on the first three. All of them except circuit board design can be done on a computer with absolutely no graphics capabilities.

The CP/M operating system, the world standard before the IBM-PC came along, made for useful, even elegant computers. Only one thing was lacking – graphics. But nobody seemed to care; if nobody else had graphics, *you* didn't need them either to 'keep up with the Jones's'. You just got down to the work at hand. Such as...

Word processing

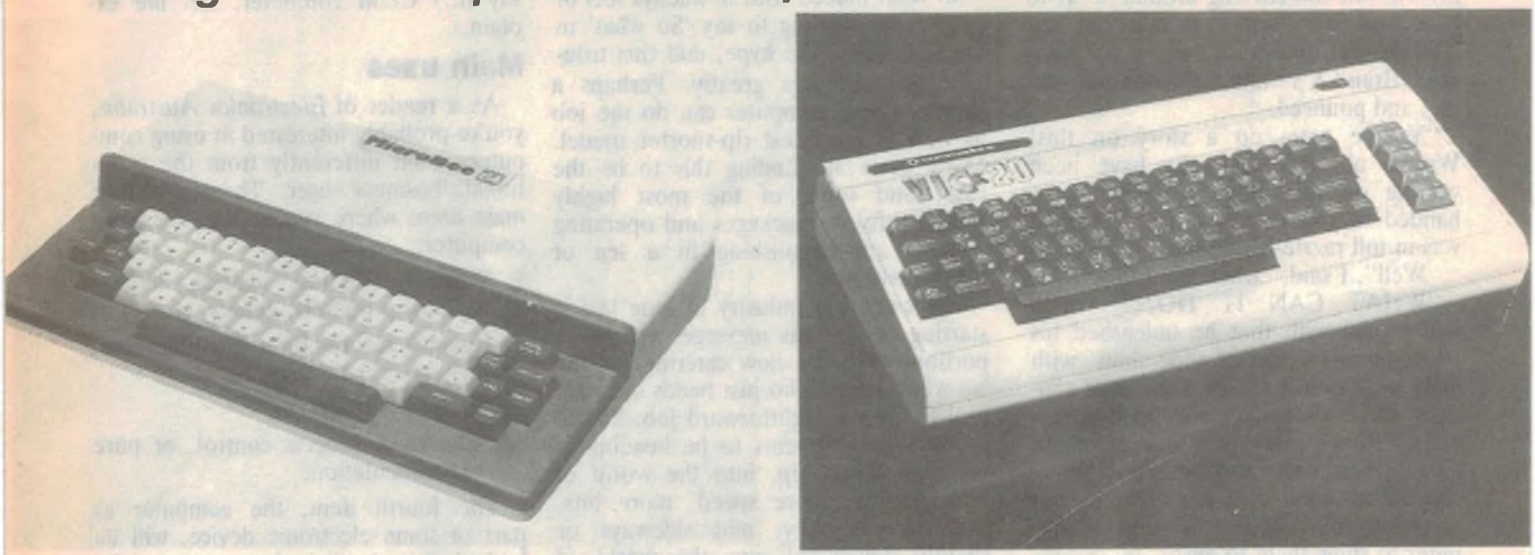
'Power' users of mega-computers can spend hundreds, even thousands of dollars, on a word processor. These are sometimes sold along with spreadsheets and databases as 'integrated packages'. Or they may be served up as 'desktop publishing'. But the fact remains that word processors are basically electronic typewriters that let you make instant corrections, shuffle blocks of text around, store your work on disk or get it back, and print the results on a piece of paper.

The computer word processor is better than a typewriter only because you can change *anything* you wish while your document is still in the computer, and commit the result to paper only after you're sure it's perfect. You can say goodbye to white-out bottles and retyping of pages.

The disadvantage of word processors is that they must live in relatively big computers that plug into the wall. But the laptop is now changing all that, and you can have a word processor that's as small and light as the portable typewriters of old.

Keep in mind that a word processor

Using 'obsolete' personal computers...



Two more 'obsolete' personal computers, both of which can be picked up quite cheaply on the second-hand market. At left is the Australian-made Microbee 64, with the Commodore Vic-20 at right.

is nothing more than a computer program; it certainly isn't some kind of magic spell. It is simply a tool, and YOU are in control of it, just like with your electric drill. And there is one classic word processor program that stands out above all the others: WordStar.

Experts will tell you that WordStar is old hat now, totally obsolete, but hundreds of thousands of people around the world are still using it as a matter of choice, in preference to the 'state of the art' packages.

Even our editor Jim Rowe sits in front of a computer running WordStar. Every word that appears in *Electronics Australia* has been through WordStar first. I write all my material with a form of WordStar and send it to Jim on a disk in WordStar format. The point is that you readers out there would never know that this magazine was produced with the humble WordStar, instead of some flashy desktop publishing package.

WordStar began as a CP/M program and made its way up through Version 3.3 by the time the IBM-PC made CP/M unfashionable. Version 3.3 was translated into IBM code to run on the PC, and then 'improved' through further versions. I think it's up to Version 5 now. But each version became bigger and more memory hungry, and the latest WordStar demands something like two megabytes of disk space.

If you're going to get WordStar, I think Version 3.3 is still the best choice. The CP/M and IBM versions appear to be identical in every way. If you can lay your hands on a good used CP/M computer such as a Kaypro or Osborne or Microbee, that along with WordStar 3.3 will do everything you'll ever need for basic word processing. And if you eventually move to an IBM-style PC, you'll find that the PC version of WordStar 3.3 is a familiar old friend. I doubt you can even buy a new copy of WordStar 3.3 now, but there should be plenty of them around on the used market.

Another word processing option is to get a WordStar clone, probably as a Shareware program. Shareware software is virtually non-commercial – you pay for it if you like it – and it's very cheap. WordStar clones are available in both CP/M and IBM formats.

I'm not actually using WordStar now, but a clone called VDE (Video Display Editor). You type your material into it exactly as with the proper WordStar, but the whole program is written in machine code so it's lightning fast. VDE comes in both CP/M and IBM versions. Some other Shareware word processors can be configured to work exactly like WordStar, and even the editor in the Turbo Pascal language is set up to look like WordStar. As I said, it's truly a classic.

Record keeping

Small businesses generally need to store information such as customer records in some kind of orderly system ('database' is the proper term). It is also necessary to keep financial records, so you know where your income comes from and who you owe money to.

Database programs can be horribly complicated, so that you need to know a special programming language just to set them up. But there are some very simple options that you don't hear much about, until now at least.

I use a little program called Cardbox, which is simply a computer simulation of a metal box filled with 3x5 index cards. The cards can be anything you want; I keep one file with cards containing details of interesting radio stations I've come across. Another file has cards with names, addresses, and companies of contacts I have within the electronics industry.

Cardbox can search through its collection of cards and isolate all of them that match certain characteristics. For instance I can tell Cardbox to find all the card records of electronic suppliers which are based in Adelaide (two characteristics), and it will select three or four out of perhaps 100 in the box. I can then flip through them, just as if they were paper cards. What you see on the screen is an image of a real card with all the information neatly typed into the proper places.

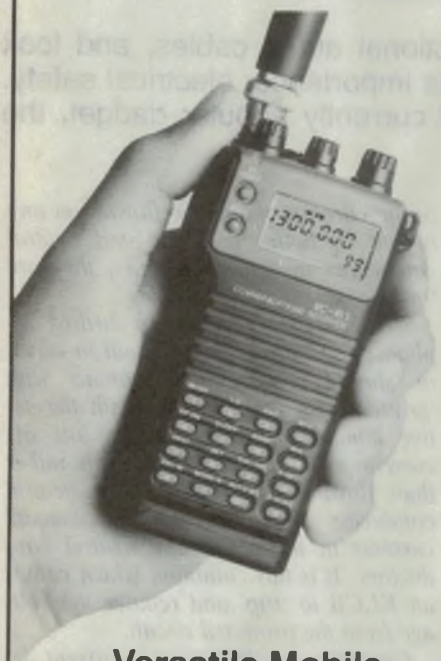
Like WordStar 3.3, Cardbox is probably a bit past it now and not actively marketed, but as far as I'm concerned it's still as useful as ever. It comes in both CP/M and IBM versions. Perhaps it's still available on the used market. There are also Shareware versions; one I think is called Cardfile.

Financial records are usually kept in a program called a spreadsheet, which is simply a 'rows and columns' ledger book. A computer spreadsheet does all the adding up for you after every new entry or change. But addition is only the start; computer spreadsheets can do all the normal maths functions as well

Continued on page 149

4 inches high, 1000 MHz wide puts the world in your pocket

The New IC-R1 handheld receiver



Icom, leading the way again in communications technology and mini aturisation with the world's smallest wide band receiver.

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FORUM

Conducted by Jim Rowe

Earth-leakage circuit breakers: just how much safety DO they provide?

Let's take a break this month from esoteric things like unidirectional audio cables, and look again at a subject whose perennial interest is exceeded only by its importance: electrical safety. In particular, the exact nature of the protection afforded by that currently popular gadget, the 'ELCB' or earth-leakage circuit breaker.

It's not that I'm short of letters on the subject of fancy audio cables; in fact quite a few have arrived in the last few weeks, and I'll try to deal with them next month. No, the reason I'm changing the subject, for this month at least, is that a couple of weeks ago another letter arrived, drawing attention to an aspect to electrical safety which we haven't considered for some time – if ever. This is the matter of earth leakage circuit breakers, formerly called 'core balance relays'.

ELCB's have been in the news quite a lot of late, and I think at least one state has recently enacted legislation to force all new domestic electrical installations to be fitted with one. There are small portable ELCB's now on sale at almost every hardware store, promoted heavily on the basis of increased electrical safety.

But *are* ELCB's quite the universal safety panacea that the marketing people would have us believe? That's the question posed – and at least partly answered – by the writer of the letter concerned, Jeff Thomas of Engadine in NSW. His letter is fairly self-explanatory, as you can see:

Let me first qualify my forthcoming observations by stating that I am a professional electronics engineer, a qualified electrician and licenced electrical contractor.

My concern and purpose for writing this letter is the false sense of security being offered to the public by the current campaign surrounding earth leakage circuit breakers (ELCB's), and in particular the relationship between ELCB's and double insulated appliances.

The impetus for the current wave of publicity concerning ELCB's was the electrocution of a five-year-old child in a bath, due to a hair dryer falling into the water while connected to the mains. While this is obviously a tragedy in itself, the other tragedy is that the child probably would not have been saved had that circuit been 'protected' by an ELCB.

Consider the situation of the present day bathroom. The bath would probably be of steel or cast iron construction, with a generous(?) coating of vitreous or synthetic enamel – an insulator. This bath would then be supported on probably a timber structure, sitting on a compressed fibrous cement floor – more insulation.

Some baths have provision for fitting taps directly into the bath, while others require the taps to be fitted externally in the wall or surrounds. In any case if the taps were fitted directly to the bath, the plumber would probably have been careful not to chip the coating on the bath as they were tightened down, so there would be no electrical contact between the bath itself and the metal plumbing system.

The drainage system to the bath would almost certainly be glued plastic, and thus the whole structure would be sitting well and truly above electrical 'earth'.

So where's the out-of-balance electrical leakage current going to go, if a non-earthed (double insulated) appliance falls into the well insulated body of water? Nowhere!

An ELCB relies for its operation on an out-of-balance current being present, between the active and neutral conductors in the circuit. In general in this country we work on a Main Earthed Neutral (MEN) system, whereby the neutral is tied to earth at each consumer's switchboard. Consequently the neutral is generally within a few volts from earth potential anywhere in the system, and the active is somewhere about 240V AC above earth. Under normal circumstances it is obvious that equal and opposite currents should be flowing at any instant in both the active and neutral conductors in a circuit – i.e., they are 'in balance'.

Should a fault occur in an earthed appliance, creating a leakage path to earth, or should somebody in contact with 'ground' also make contact with the active conductor, some (maybe lots of) current will be diverted to earth rather than flowing back through the neutral conductor. This will result in unequal currents in the active and neutral conductors. It is this condition which causes an ELCB to 'trip' and remove the voltage from the protected circuit.

Generally the difference in current detected at the trip point is as low as 10 to 30 milliamps, depending on the type of device used, and the time taken to trip is as the literature claims 'within a third of a heartbeat'. This is all very well, but let's now get back to the bathroom situation.

A double insulated appliance has, by law, no earth conductor to the appliance. So if the water in the bath is not earthed, and the appliance is not earthed, and that appliance ends up in the water when somebody is also in the water, what happens? Zap!

Because wet skin makes a relatively good conductor, and because there would be quite an intense electric field in the water, a considerable amount of current would start flowing through the person, causing electrocution.

Now because no current is flowing anywhere except up and down the active and neutral conductors, no out-of-balance situation exists – hence the ELCB does not trip. About the only thing that might save the hapless being in the bath, in these circumstances, would be if they made a grab for a tap, or some other hunk of 'earth'. A child probably

Something that could happen quite easily, in many bathrooms...

Why is a shock in this kind of situation so often fatal, even when there is no direct path to earth? Simply because, as Jeff Thompson points out, wet skin makes a relatively good conductor. And when you're sitting in water, there is normally a large area of skin in direct contact with the water. As the human body is also composed largely of water, its internal 'bulk resistance' is also relatively low.

So when you're sitting in a bath, your low internal body resistance is very well connected via the low resistance of a large area of wet skin, to the equally low resistance bathwater. Should any current start to flow, there's no reason why a very significant component of that current can't flow through YOU. And it takes only a few tens of milliamps to produce cardiac arrest.

It's obviously a far more dangerous situation than that in say a typical workshop or lab, where you're likely to be dry and clothed. With only a tiny area of dry skin ever likely to be in contact with an active circuit, should a fault develop, the risk of electrocution is much lower.

Of course the risk of serious shock occurring in a workshop will be much greater if you're working in bare feet on a wet concrete floor. So don't infer from what I've just written that you can't get killed in a workshop or lab, whatever you do. It's still a wise idea to wear rubber-soled shoes whenever you're using electrical tools or equipment – especially when you're on damp ground, or a damp concrete floor.

What I'm saying, and what Jeff Thomas has pointed out, is that when you, me or our loved ones are sitting in a bath, we're all *especially* vulnerable to shock. And that despite all of the hype about ELCB's, these really don't offer any protection at all *unless* you're connected to earth.

Frankly it seems to me that the main lesson to draw from all this is to avoid using electrical appliances in a bathroom when *anyone* is in the bath. It's just too risky, in my opinion.

But I suppose if you *must* use a hair dryer in this highly risky situation, then at the very least you should (a) have your house wiring fitted with an ELCB; and (b) follow Jeff Thomas's advice about fitting a metal earthing chain to ensure that the bathwater is reliably connected to a known earth – so that the ELCB can actually provide you with some protection.

Note that there's no point in just installing an ELCB, and not fitting the earthing chain. Without the chain, the ELCB simply can't provide any protection – at least against the risk of bathtub electrocution.

Perhaps Jeff Thomas is also right, that we should try to have the electrical safety authorities require double insulated appliances to be fitted with an internal earthed plate, to ensure that an earth leakage current is bound to occur if water enters the appliance.

A small plug-in ELCB marketed by HPM: the 'Electresafe' DLD 5030.

Somehow I don't like our chances, though. For this to work, double insulated appliances would have to be fitted with three-wire cords and three-pin plugs. Mention this to the same safety authorities, and they're likely to have apoplexy – currently they spend an enormous amount of time and effort ensuring that double insulated gear is never earthed, at least via a three-wire cord and plug!

Seriously though, it's a very sensible idea. Having an internal earthed metal plate is not at all the same as having an external earthed metal case. And the main argument against the latter is that faulty plug, extension cord or power outlet wiring could allow the case to become alive. With the 'earth' connected only to an *internal* metal plate, this couldn't happen.

It could even be, I suspect, that in making this suggestion to improve the level of protection offered by ELCB's, Jeff Thomas has actually also hit upon the solution to many of the 'tingle' and hum problems produced by a lot of double-insulated equipment. If double insulated gear could legally be provided with an internal earth connection, made via the mains cord, it would become easy to bleed away the capacitive currents that cause many of the problems we've discussed in previous columns.

So his suggestion is well worth serious consideration, I believe. What do *you* think?

By the way, has anyone experienced trouble with an ELCB tripping due to the earth currents produced by RFI suppression capacitors, in earthed equipment? I suspect that this can probably happen, especially if the capacitors are larger in value than is specified in the current regulations. Even though the capacitive current to earth will be 90° out of phase, it will probably still be capable of tripping the ELCB – although this may depend upon the particular design.

A final note, before we leave this subject for the present. Nothing in the foregoing discussion is meant to suggest that ELCB's are not worth using, in the interests of safety. There are likely to be many situations where a faulty appliance or accidental situation could cause you or your loved ones to become connected between the 240V and earth – and in such situations, an ELCB may well save a life.

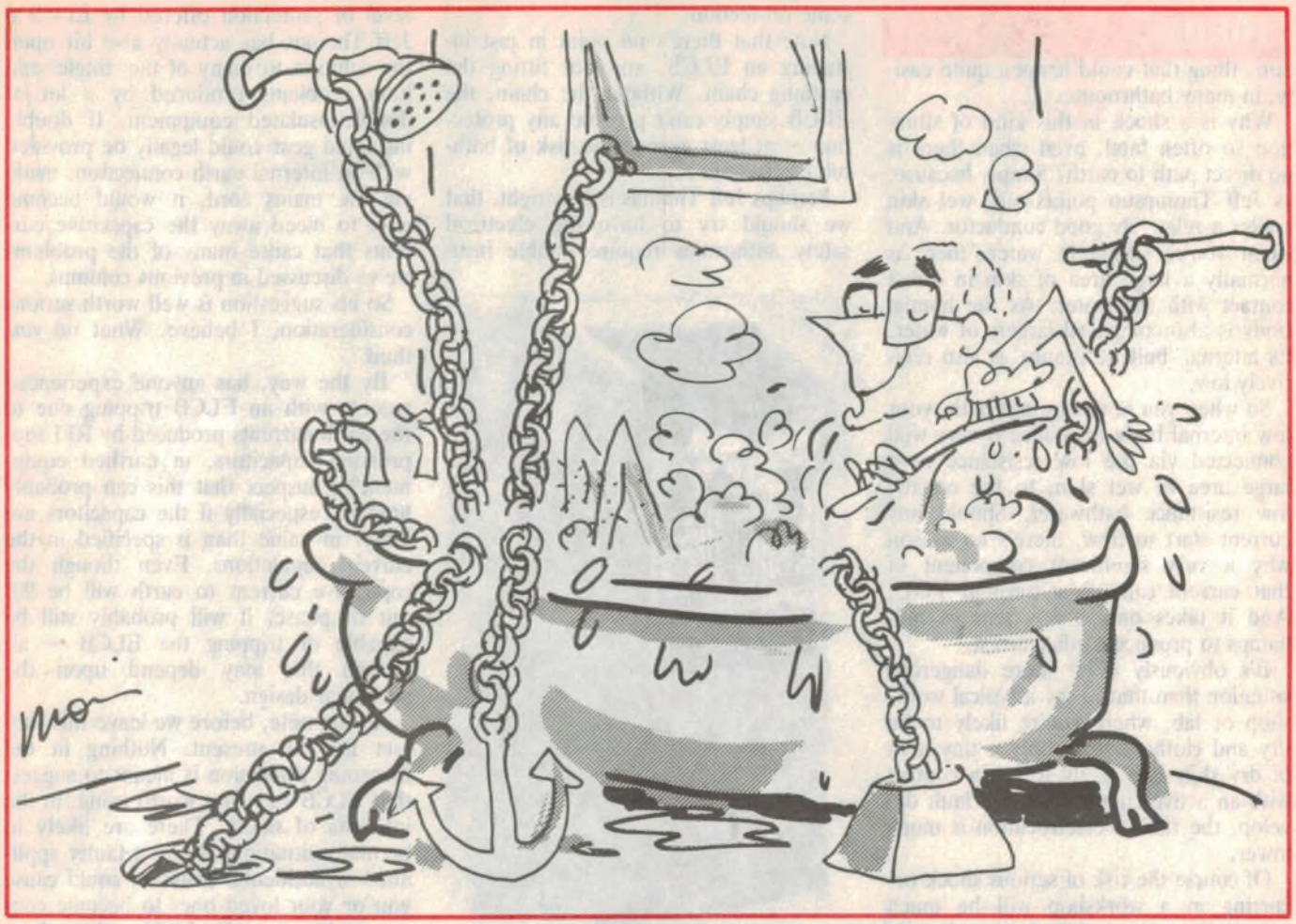
The thing you should bear in mind is that an ELCB can only detect a problem if this produces a sudden change in the current balance between the active and neutral power lines. That's simply the way the thing works.

So ELCB's are well worth having; but they aren't a magic cure-all. As Jeff Thomas has pointed out, an ELCB can only protect you if you become part of a circuit to earth – not if you end up connected between active and neutral. And the current to kill a human is far lower than that needed to blow a fuse, or trip a normal circuit breaker.

Shortform kits

Changing the subject again, some time ago when we were discussing electronic project kits and component supply, it was suggested that a significant number of project constructors resented being 'forced' by suppliers to buy complete kits. This was taking away half the fun, it was said – especially by the more experienced project builders.

The people concerned expressed the view that being forced to buy a com-



wouldn't be able to do this.

In case you were wondering, this is not just a theory. A colleague of mine, after some discussion about the problem, tested the theory by throwing a bare bayonet fitting attached to a lead plugged into an ELCB 'protected' circuit, into a bath in just such a situation as described above. (But without the child – some wives lose their sense of humour at times...) There was plenty of hissing and crackling – but no tripping of the ELCB!

What is the solution?

In the short term, one solution I have implemented in my own bathroom is to go and buy a length of decorative metal chain, attaching one end securely to a tap and the other end to the bathplug. The plug has to be in the bath for any decent amount of water to be present, and that water will therefore be earthed through the metal chain back to the plumbing system.

This if course will not work if you have high pressure plastic water pipes in your installation – then you would have to find an alternative earth point.

In the long term it may be worth applying some pressure on 'the authorities' to allow – indeed require – some form of earthed metal plate or ring WITHIN an otherwise double insulated appliance, just so that water ingress will cause enough out-of-balance current to trip an ELCB.

The purpose of this letter is not to cause discussion. The problem is the facts as stated above; the purpose is to vent the problem to the community and hopefully cause some action.

At the very least, let's hope we can save a life by dispelling that false sense of security surrounding earth leakage circuit breakers.

Just when you thought it was safe to go into the water!

Thanks for drawing our attention to the problem, Jeff – I'm sure many readers will applaud your public spirit. You're probably also going to cause a sudden sellout of decorative metal chain in Australia's hardware stores, as soon as this issue hits the streets!

Incidentally while Jeff refers in his letter to traditional metal baths with an insulating layer of vitreous or synthetic enamel, many modern baths are made entirely from epoxy fibreglass. But as this is fully insulating, there will be even less chance of a leakage circuit existing to earth – unless you follow Jeff's advice and fit an earthing chain to the water tap and bathplug.

It's ironic, isn't it, that one situation where an ELCB *isn't* likely to offer any real protection against electrocution is that in a typical domestic bath – one of the most likely of all places for shocks to occur! Sobering, too.

As Jeff Thomas points out, the whole basis for using an ELCB as a protective device is the assumption that if a dangerous fault should develop, some of the current normally passing between active and neutral will be diverted directly to earth – so that the currents in the two main conductors will no longer be equal. But if there is no available path to earth, this simply can't happen – and the ELCB cannot sense that a fault has developed.

Yet as Jeff has also explained, it's still all too easy for a person to be electrocuted, without having any direct connection to earth. All you need is to be sitting in a bath of water, which is suddenly connected between active and neutral by the immersion of a normal unearthed, double insulated hair dryer.

plete kit prevented them from using parts they may have in their 'junk box', left over from previous projects. It was also producing a generation of 'lazy' electronics people, they said, who would only build a project or a piece of gear if it was available as a fully packaged kit – complete down to the last nut and bolt.

Why can't we buy just the bits we need, they asked, or at least a 'short-form' kit, with say only the PC board and the other special or hard-to-get components?

In short, there was a suggestion that at least some of the electronics retailers and kit suppliers might be cynically manipulating the poor electronics constructors, by forcing them to buy complete kits.

Now I suspect that a small amount of this does go on at times, although not necessarily for the above reason.

Fact number 1: from time to time many components – especially those that have only recently been developed, or are fairly specialised – can be hard to get or in very limited supply. So there are often situations where a supplier can only get hold of a relatively small number of the specialised 'crucial' parts for a particular project.

Fact number 2: from what I've learned from the various electronics retailers, the majority of today's electronics constructors now seem to be essentially kit builders. Whether from 'laziness' or sheer lack of time to chase parts, they simply prefer buying complete kits. This seems to apply to technicians and hobbyists alike; perhaps it's a symptom of our frantic lifestyle.

Putting these two things together, the retailer/kit supplier with limited stocks of the crucial parts for a project is faced with a choice: do they make the parts available separately, for the sake of a few independent constructors (who may or may not choose to buy from them), or do they use them to make up a batch of complete kits – to please the rather larger group of kit builders?

The choice is fairly clear, don't you think? The complete kits are obviously far more likely to sell, as well as providing more cash turnover. You'd do the same if you were in the same position, I'm sure – be honest!

Most of the time, though, the majority of retailers and suppliers are surely happy to sell customers whatever they want: separate parts, short-form kits or complete kits. It's all business, and the more choices you provide the more likely you are to make sales.

In fact following some of the discussion of these topics late last year, Dick Smith Electronics decided to provide a range of 'short form' kits for various projects, in addition to their fairly extensive range of complete kits. These were intended especially for the more experienced constructor – those with a bulging 'junk-box', as well as those who wanted to adapt a published design for other purposes. In many cases they included mainly the PC board and other special parts.

The kits were for a variety of projects, from amateur radio gear to amplifiers and remote controllers. And as you would expect, they were priced considerably lower than full kits for the same projects.

DSE also decided at the same time to make available PC boards for many of the projects, for those that were even more 'independant'. Both these and the short-form kits were launched in December 1989, and have been advertised fairly regularly since then.

Well, what do you think was the response? I gather it's been very disappointing. DSE still has many of the kits and boards in stock, despite having reduced the prices even further, to try and make them more attractive.

Where *are* all of those people who complained about not being able to buy short-form kits, and PC boards? That's the question DSE's bemused kit people are asking – one can hardly blame them.

It really does look as if the number of people who want to 'do their own thing' in constructing electronics projects is now even tinier than we thought. So tiny, in fact, that perhaps DSE and the other kit suppliers would be quite justified in ignoring them altogether, and concentrating on the majority.

To me this would be a pity, but perhaps it's inevitable.

What do you think? It's a subject that should hopefully generate a bit of interest, if there's any future in electronics construction as a rewarding activity. So let us know your views, folks.

And if *you* are one of those 'independant' constructors who's keen on seeing firms like DSE stocking PC boards and short-form kits as well as the complete caboodle, how about checking out the DSE range, and putting a few dollars where your mouth is? This is probably the only way to change their minds about calling off the whole exercise as a failure.

I gather the boards and short-form kits have been withdrawn from stock in all the stores, but are still available on order from the mail order department.

See you again next month.

SPECTRUM

Communications News & Comment

ICOM MINIATURISES COMMERCIAL VHF HANDHELD

Recently, Icom's new miniature amateur band handhelds were released and they've apparently been popular. But, there was the inevitable question, "Where's the commercial version?"

Now miniaturising VHF equipment isn't as easy as miniaturising UHF. The problem is, of course, that many components are just that much larger at VHF. Commercial specifications are also more demanding than those for amateur gear. To be able to cram everything in, do it in such a way that 100% reliability is assured and keep the device right up to spec. is no mean feat. But Icom engineers have done just that, with the new IC-H10 VHF handheld.

While it is small in size, the unit is a giant in performance: it has up to 5W output (with suitable battery pack), a full 26MHz bandwidth (with no adjustments required) and a variety of sophisticated user features. Yet it's just 58 x 85 x 29mm (w x h x d) and weighs in at only 205g. Add your choice of battery pack and it's still only 400g, and just 155mm high. So it will easily fit into your shirt pocket , without straining the stitches!

The IC-H10 covers a full 26MHz (148-174MHz) with up to 10 transmit and receive frequencies programmable. Unlike many VHF transceivers, no crystals or diode matrix are required: the IC-H10 has an EPROM to remember all your details.

Further information is available from your nearest Icom dealer. To find out who that is, contact Icom Australia at 7 Duke Street, Windsor 3183 or phone (03) 529 7582.

WIDEBAND DISCONE ANTENNA: 25-1300MHZ

The latest breed of wideband HF-VHF-UHF communications and scanner-monitoring receivers has renewed interest in discone antennas. The discone configuration provides exceptionally wide bandwidth coupled with an omnidirectional coverage in the horizontal plane, making it very suitable for this kind of use.

The only problem is that discone antennas are not exactly thick on the ground – let alone up the mast. Icom markets one, the AH7000, with a rated bandwidth of 25 – 1300MHz. As well as being suitable for wideband reception it can also double as an emergency antenna for transmitting use, easily handling 100W input on the 50MHz, 144MHz, 430MHz, 900MHz and 1200MHz bands.

Apparently the demand for the AH7000 has been so great that Icom Australia's stock was cleaned out recently, and the firm had to increase its orders from the factory. But the new stocks have now arrived, and the antennas are again available.

The AH7000 comes with about 10m of high grade co-ax, fitted with a type N plug. Adaptors are readily available for other connectors.

Further details are available from Icom dealers, or from Icom Australia, 7 Duke Street, Windsor 3181 or phone (03) 529 7582.

VESTIGIAL SIDEBAND CATV MODULATOR

The Nexus VM-1 vestigial sideband modulator is designed for small to large CATV, broadband and inhouse monitoring systems.

Incorporating surface acoustic wave (SAW) filters for accurate vestigial sideband response, the VM-1 blocks out any unwanted spurious products less than –60dBc down. A high output level of 120dBuV (60dBmV) together with the various options makes the VM-1 suitable for various types of systems, as large as 60 channels.

Options include group delay filtering, IF looping and stereo audio.The modulators are available in any PAL standard, NTSC or SECAM.

The VM-1 is a low profile (1U) 19" rack mountable unit, making it ideal for compact head end installation. Extremely easy to set up, it has video and audio indicators and controls to control overmodulation. Over 200 units have already been supplied to the Australian market to date.

For further information contact MMT Australia, 124 Boronia Road, Boronia 3155 or phone (03) 762 6455.

MOBILE PHONES GIVE FLEXIBILITY

Mobile phones will let business executives of tomorrow choose when and where they will work, a Sydney conference was told recently. Ms Candice Gartner, National Marketing Manager for Telecom Mobile Communications, said productivity demands will mean more than an eight-hour day for most.

"But at least in the nineties we will be freer to decide when we'll work, when we "play and when we will do both" she said.

Ms Gartner said mobile phones had shed their yuppie image and had become essential tools for small business, trades people and their customers.

"Mobile communications are for everybody and soon they'll be everyday necessities, just like the fixed telephone, colour television, video recorders, compact discs and personal computers," she said.

"They're not fads and they're not elitist. They have a fundamental role in Australian society and its changing face."

Ms Gartner said that within 10 years, more than 60% of all telephone calls in Australia would involve mobile technology.

EARTH STATION FOR ANTARCTIC TV

A new earth station commissioned for Telecom New Zealand will provide a novel entertainment facility for American support groups working in the Ant-

UPGRADED PHONE CALL SEQUENCER

Voca Communications has announced the release of its updated telephone call sequencer, the digitised CS-D40, which now has a capacity of 40 incoming telephone lines as opposed to the old unit which could only handle 12 lines.

All incoming calls are answered on a 'first-called, first answered' basis. When answered by the machine, callers are delivered a message and then placed on hold with either a further message or music-on-hold. If callers are kept waiting longer than a pre-programmed time, they are then delivered a second message while the operator receives an alarm to alert them to answer the call. An attendant monitor advises the operator of the oldest call in the group.

The CS-D40 has a 'barge-in' or 'start-to-finish' option which can be selected according to the length of the outgoing message. On shorter messages, callers can receive information from the beginning as soon as they are connected, while on lengthier messages, callers can 'barge-in' to the message in progress when they call.

Up to five lines can be placed on a priority setting, allowing certain programmed numbers to be answered first, such as STD-free 008 numbers.

An optional printer enables hard copies of traffic information to be produced at regular programmable periods. This not only allows businesses to roster staff accordingly but is also ideal for direct response companies to measure results.

For further information, contact Voca Communications, 11-29 Eastern Road, South Melbourne 3205 or phone (03) 697 7000.

arctic. The new station, with an 11-metre diameter antenna, was supplied and installed by the Australian arm of Scientific Atlanta Inc.

The earth station, sited near Christchurch in the South Island of New Zealand, will receive entertainment programmes beamed to US armed services around the world from an American transmitting station as part of the Armed Forces Radio and TV Services (AFRTS) network.

The programmes beamed to the Pacific area via the INTELSAT satellite, consist of top sporting events, American and world news and other entertainment programmes aimed specifically at informing and entertaining US forces stationed in foreign countries. The service is scrambled using the B-MAC technology.

The newly-commissioned New Zealand link in the network will receive these programmes. They will then be taped and shipped to the Antarctic for replay on video cassette recorders for support groups working in the desolate reaches of the sub Continent.

PHONES FOR FIJI

Alcatel STC claims to have consolidated its position as the nation's largest exporter of telephones, with a significant sale of small business systems to Fiji.

Valued at more than $380,000, the sale is for Commander BN systems with a capacity of from three to 24 exchange lines and between eight and 64 extensions. This is a follow-on from a similar order received late last year, valued in excess of $250,000.

Alcatel STC also supplies Fiji with one and two-line Commander E models through Telecom Australia.

NEW BOOKS AND LITERATURE

Power supplies

DESIGN OF SOLID STATE POWER SUPPLIES, by Eugene R. Hnatek. Third Edition, 1989, published by Van Nostrand Reinhold. Hard covers, 235 x 160mm, 641 pages. ISBN 0-442-20768-9. Recommended retail price $XX.00.

The first edition of this book was published back in 1971, and needless to say a great deal has happened in solid state power supplies in the intervening 19 years. In fact it wouldn't be exaggerating to say there's been a virtual revolution, when you consider the developments that have taken place in switching regulators, energy converter circuits, regulator chips and power switching/-control devices.

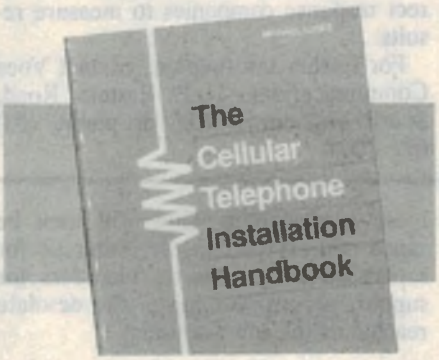
Mindful of this tremendous growth in power supply and conversion technology, author Hnatek has totally re-organised and enlarged this edition to reflect the current situation. Much greater emphasis is now given to switch-mode systems, while new material has been added to cover recent developments in such areas as high frequency operation, resonant converters, the Cuk converter, surface mount technology, MOSFET switching devices, state-of-the-art converter and power supply ICs, distributed power systems and rectifier selection criteria.

The emphasis throughout is on sound, practical engineering design – but with sufficient coverage of theory to allow this to be done. The author is Manager of R&D at Viking Labs, a subsidiary of Honeywell, and is a noted authority on ICs with some 10 books, 40 papers and 250 articles to his credit.

After a general introduction to power supplies, he covers the important subject of switch-mode systems. Then follow chapters dealing in turn with the various building blocks – transformers, inductors, power switching devices, IC voltage regulators and controllers, and magnetic amplifiers. There's also a section on the important topic of electromagnetic compatibility. Then in the final section of the book, he gives a detailed discussion of the design of some 10 different kinds of supply. These include a two-transformer DC/DC converter, a regulated flyback EHT supply, a high efficiency Cuk converter, a frequency-controlled resonant DC/DC converter and a high peak-current supply for a high speed matrix printer.

The text is concise, but quite readable, and is well served by illustrations. In short, it seems a very comprehensive text and reference book on the design of power supplies and converters.

The review copy came from the local office of the publisher, at 480 La Trobe Street, Melbourne. (J.R.)



Cellular phones

THE CELLULAR TELEPHONE INSTALLATION HANDBOOK, by Michael Losee. Second edition, published by Quantum Publishing, 1989. Hard covers, 242 x 196mm, 237 pages. ISBN 0-930633-05-9. Price including $75.

A comprehensive and down-to-earth guide to cellular radiotelephones, written mainly for the electronics technician who wants to set up in business as an installer or repairer. The author has a great deal of experience with the US cellular phone system, being Product Development Manager of Nokia-Mobira – one of the leading international cellular equipment makers. He is also Technology Editor for the US magazine *Cellular Business*, and a well-known and quoted industry spokesman.

Naturally enough the book deals specifically with the American 'AMPS' (Advanced Mobile Phone Service) cellular system, but as Australia is adopting the same system this should pose very few, if any problems. In fact from an inspection, my impression is that the only part of the book which will be of little use or interest to Australian readers is a list of US equipment suppliers, given in one of the two data appendices at the end.

Apart from this, the book seems to cover the subject of cellular phones rather well. It begins with a brief chapter on the history of cellular, followed by an introduction to the basic theory and operation of cellular systems. This is followed in turn by chapters on test equipment and tools, cellular telephones themselves, antenna theory and selection, vehicle installations, marine installations, fixed rural installations and finally troubleshooting and repair techniques.

The author is obviously an experienced writer, and his text is concise and highly readable. It's also well served by clear illustrations. As a result it seems an excellent introduction and reference book on cellular 'phones, especially for the technician who is more interested in the practical side than in a lot of heavy theory.

The review copy came from DNA Communications, of 10 Welch Street, Southport 4215, and the price quoted includes packing and postage throughout Australia and New Zealand. Further information is available from DNA by phone, on (075) 914 956. (J.R.)

Telecom myths

TELECOMMUNICATIONS: THE TIME FOR TRUTH, by Jack Keavney. Published by Jack Keavney, 1990. Soft covers, 210 x 148mm, 130 pages. ISBN 0 7316 9575 5. Recommended retail price $12.95.

Back in the February issue, I commented in the editorial column on a

first-hand report comparing the performance of Telecom Australia against five major overseas telecommunications systems, by Jack Keavney. It certainly gave a lot of food for thought, with regard to the ongoing debate about deregulation, private competition and the mooted amalgamation of Telecom, OTC and Aussat to create a 'Megacom'.

By the time you read this, some of these matters may have been resolved by the Federal Government. However as I write this review in mid-June any such decision is in the future and Mr Keavney has just published this new book, presenting a lot more facts and figures comparing the telecom situation here with that in other countries. Subtitled 'The Myths of Deregulation' it's based on material gathered during a second trip to the countries concerned, earlier this year, in which he interviewed representatives from consumer associations, telecom companies, unions and regulatory bodies.

I might add that Mr Keavney has published the book entirely at his own (considerable) expense, and his trips were also self-funded. The whole exercise has been to help ensure that whatever decisions are made by Australia in this important area of national communications policy are made on the basis of objective evidence regarding overseas experience, rather than blinkered ideology. We've certainly seen quite a lot of the latter.

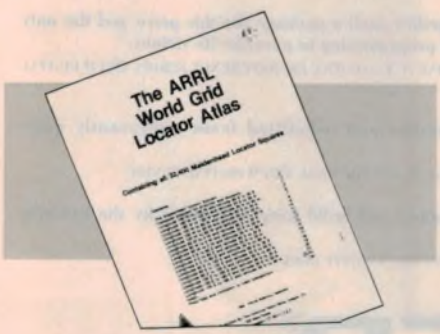
Jack Keavney is a former National Director of the Freedom from Hunger campaign, Foundation Chief Executive of Enterprise Australia, Founding Director of the Australia For Quality Programme and a noted authority and consultant on Total Quality Management. He has published an earlier book called *Private Enterprise*, dealing with the legitimacy of profit and the benefits of competition. So he's not only a very public-spirited individual, but a champion of competition, efficiency and quality of service.

Despite this background, and on the basis of his trips and experience, Mr Keavney is convinced that Australia could make a very bad mistake by following blindly the kinds of telecom system deregulation that have occurred in countries like the USA, the UK and Canada. And in this book he presents his evidence, in a clear and dynamic fashion.

It makes very interesting and thought-provoking reading. I only hope that if decisions on Telecom Australia's future have been made by the time you read this, due account will have been taken of the evidence he presents.

But even if this doesn't happen, it's a book I can highly recommend.

Copies of the book should be available from major bookstores, but if you experience any trouble it's also available in NSW from St George Business Centre, 3rd Floor, 2 Cross Street, Hurstville 2220 or phone (02) 580 0440, and in Victoria from TQC Equipment, PO Box 381 Heidelberg West 3081 or phone (03) 459 7620. (J.R.)



Grid locator

THE ARRL WORLD GRID LOCATOR ATLAS, by Folke Rosvall, SM5AGM. Published by the American Radio Relay League, 1984. Soft covers, 278 x 215, 24 pages. Recommended retail price $8.00.

This handy reference atlas for the DX enthusiast was prepared by Swedish amateur Folke Rosvall, SM5AGM. It provides not only a set of maps giving the codes for each location, but also general information on the system and a couple of programs in BASIC to allow use of your personal computer to calculate (a) the locator code, knowing longitude and latitude; and (b) the direction of, and distance to, any location from any other location, with both entered by code. There's also a fairly comprehensive list of countries and major cities, with their codes.

The review copy came from Stewart Electronic Components, of 44 Stafford Street, Huntingdale 3166 (PO Box 281, Oakleigh 3166), which can supply copies by mail for the price quoted. (J.R.)

To Choose The Best In Sound Quality, Be Guided By The Critics

"It was clear and detailed with a crisp and attractively positive presentation. Dynamic range was wide and the player produced vivid stereo with clearly localised images."

JIMMY HUGHES, HI FI ANSWERS MAGAZINE (U.K.) ON THE PD91 REFERENCE SERIES C.D. PLAYER.

"I am forced to note that the sheer goodness of the Pioneer revealed starkly the inconsistent engineering standards at the BBC and other broadcast organisations."

ALVIN GOLD, WHAT HI FI MAGAZINE (U.K.) ON THE F91 REFERENCE SERIES AM/FM TUNER.

"The fidelity, lack of distortion and even the low frequency performance belied the size of the speakers, their cost and their miniscule proportions. The quality of sound was right on par with my reference speakers and I was more than impressed."

LOUIS CHALLIS, ETI (ELECTRONICS TODAY INTERNATIONAL) ON S55T LOUDSPEAKERS.

"I used it to fill a restaurant with sound for a lively office party and accepted accolades on the sound quality all night."

PAT HAYES, ETI (ELECTRONICS TODAY INTERNATIONAL) MAGAZINE OF THE Z770 "MIDI" SIZE HI FI SYSTEM.

"Pioneer's Z990 should be on the short list of anyone looking for a midi system."

CHRIS GREEN, AUSTRALIAN HI FI MAGAZINE ON THE Z990 MIDI SIZE HI FI SYSTEM.

"I see it appealing both to the audiophile wanting a good "purist" machine for sound quality reasons, as well as to the more general user."

JIMMY HUGHES, HI FI ANSWERS MAGAZINE (U.K.) ON THE PD9300 (PD71 IN AUSTRALIA) REFERENCE SERIES C.D. PLAYER.

"This player is a high quality example of the genre. Build and finish are first rate, and the lab performance was superb. Impressive in many ways, it can be recommended with confidence."

MARTIN COLLOMS, WHAT HI FI MAGAZINE (U.K.) ON THE PD6300 C.D. PLAYER.

"Given that it's a good idea having two trays, Pioneer has achieved this enhancement very elegantly and with surprisingly little additional hardware."

JIM ROWE, ELECTRONICS AUSTRALIA MAGAZINE ON THE AWARD-WINNING PDZ72T TWIN TRAY C.D. PLAYER.

HIGH COMMENDATION - DIGITAL AUDIO CATEGORY

C.E.S.A. (AUSTRALIA) AWARD TO THE PDZ72T TWIN TRAY C.D. PLAYER.

"Replay of PAL encoded discs gave superb results. It was virtually impossible to tell it from a normal broadcast picture and was miles better than standard VHS tape."

RICH MAYBURY, WHAT HI FI MAGAZINE ON THE CLD1400/CLD1450 COMBINATION C.D./C.D. VIDEO PLAYER.

"Many people will be surprised that it is a cassette based machine at all, so nearly is it in danger of transcending the natural limitations, and so authoritative is its style of delivery."

HI FI CHOICE MAGAZINE (U.K.) ON THE CT91A CASSETTE DECK.

"The CT656 is a distinguished entrant in the market for budget three head designs. It can be confidently recommended."

HI FI CHOICE MAGAZINE (U.K.) ON THE CT656 CASSETTE DECK.

"Pioneer have just launched a player which sets a standard by which others will be judged."

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ELECTRONICS · TECHNOLOGY INNOVATION

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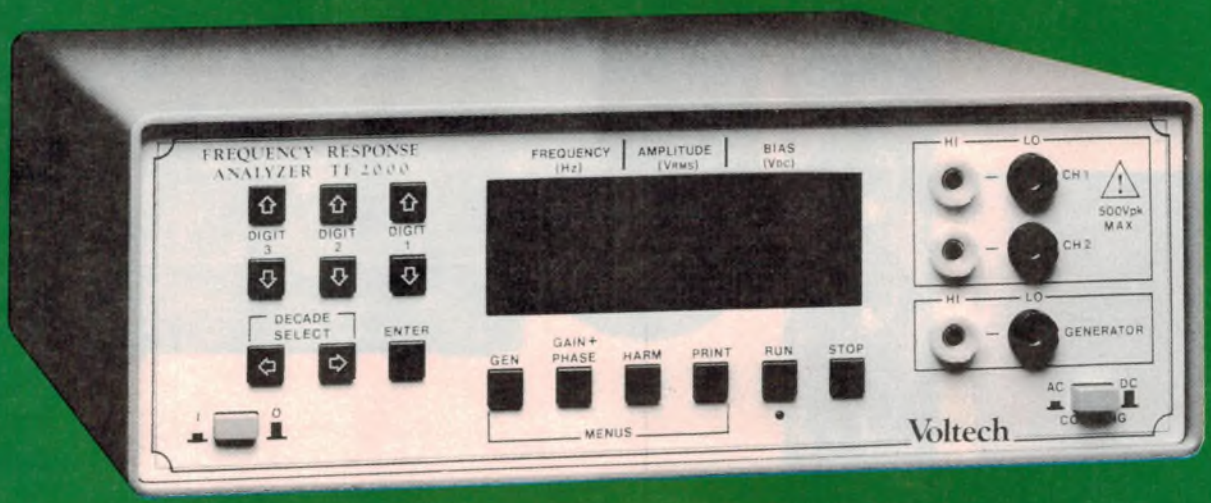
When you *analyse* it the *gains* will *phase* all other measurement systems



The new TF 2000 by Voltech is a totally self contained instrument that simply and accurately measures gain, phase and harmonics.
The TF 2000's high tech format contains its own programmable sine-wave generator and has two input channels for measurement. The generator excites the system under test and automatically sweeps over any frequency range from 0.01 Hz to 100 kHz, allowing it to cover the frequency response measurement from the largest mechanical system to the smallest high frequency dc/dc converter.
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- **Analyse vibration and stress.**
- **System analysis for modelling.**
- **Harmonic analysis of non-linear waveforms (to the 39th harmonic).**
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It's digital measurement techniques, rather than analogue, allow the TF 2000 to be more affordable than its nearest competitor. **Try less than half the cost.**
The TF 2000 follows the successful release of the Voltech PM 1000 AC Power Analyser to Australia. And is distributed by Westinghouse Systems, the industry leader in laboratory power measurement systems.

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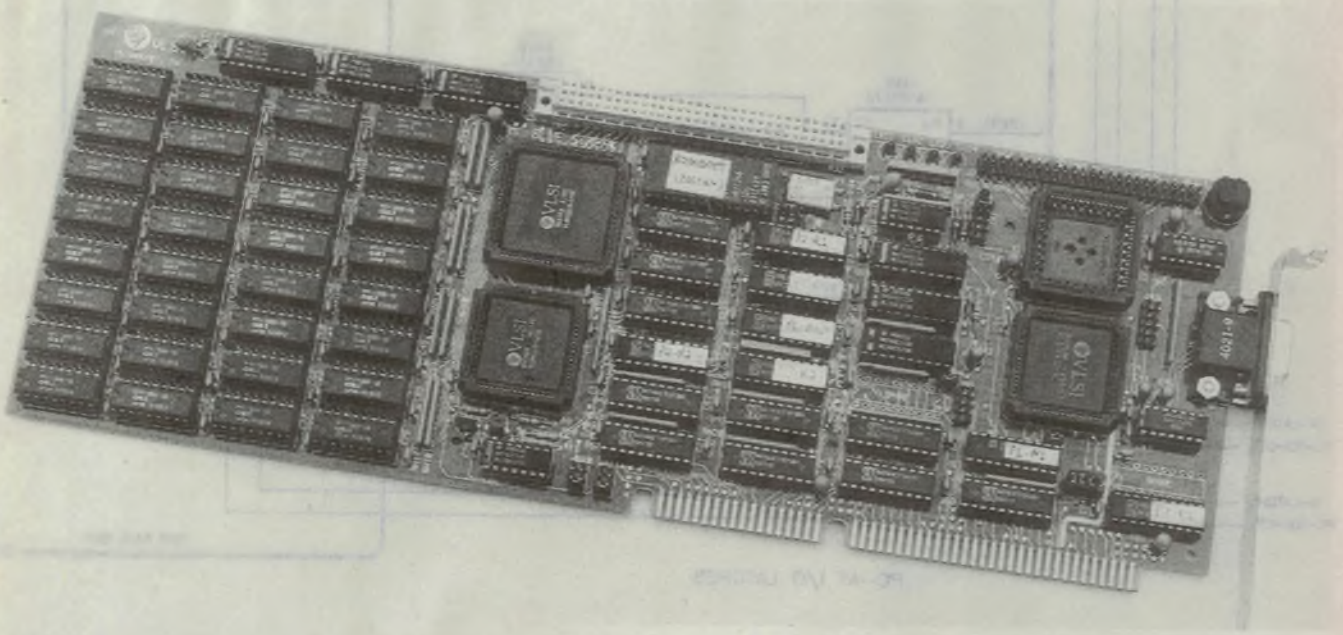
ETI Project 1630 – continued:

THE 'BLUE STREAK' RISC COMPUTER CARD - 3

In this third and final article in the series, we get to 'fire up' the project. After that, it's all up to your imagination, dedication and application. Article by Roger Harrison.



The RISC card's DRAM is organised in four banks, eight chips per bank. This gives the general circuit of each chip in each bank. The WE and RAS lines, and the 10-bit RA bus, are common to all. The four CAS lines select the bank.

Before you attempt to fire up your Blue Streak, you need to attend to the jumpers. See the accompanying panel labelled 'Jumper Configurations'. You will also have to refer to the user manual supplied with your card, because the jumper selection of RAM and EPROM depends on whether you're using 1M or 4M of RAM and the EPROM size supplied with your card.

As the LEDs on the Blue Streak card are there for user convenience, you should know a little about their functions before firing up the card for the first time. The test/demo software uses the row of four user programmable LEDs just to the right of the 96-pin expansion bus socket. They're there primarily for convenience in the initial debugging of system mode programs (they're not accessible from user mode programs).

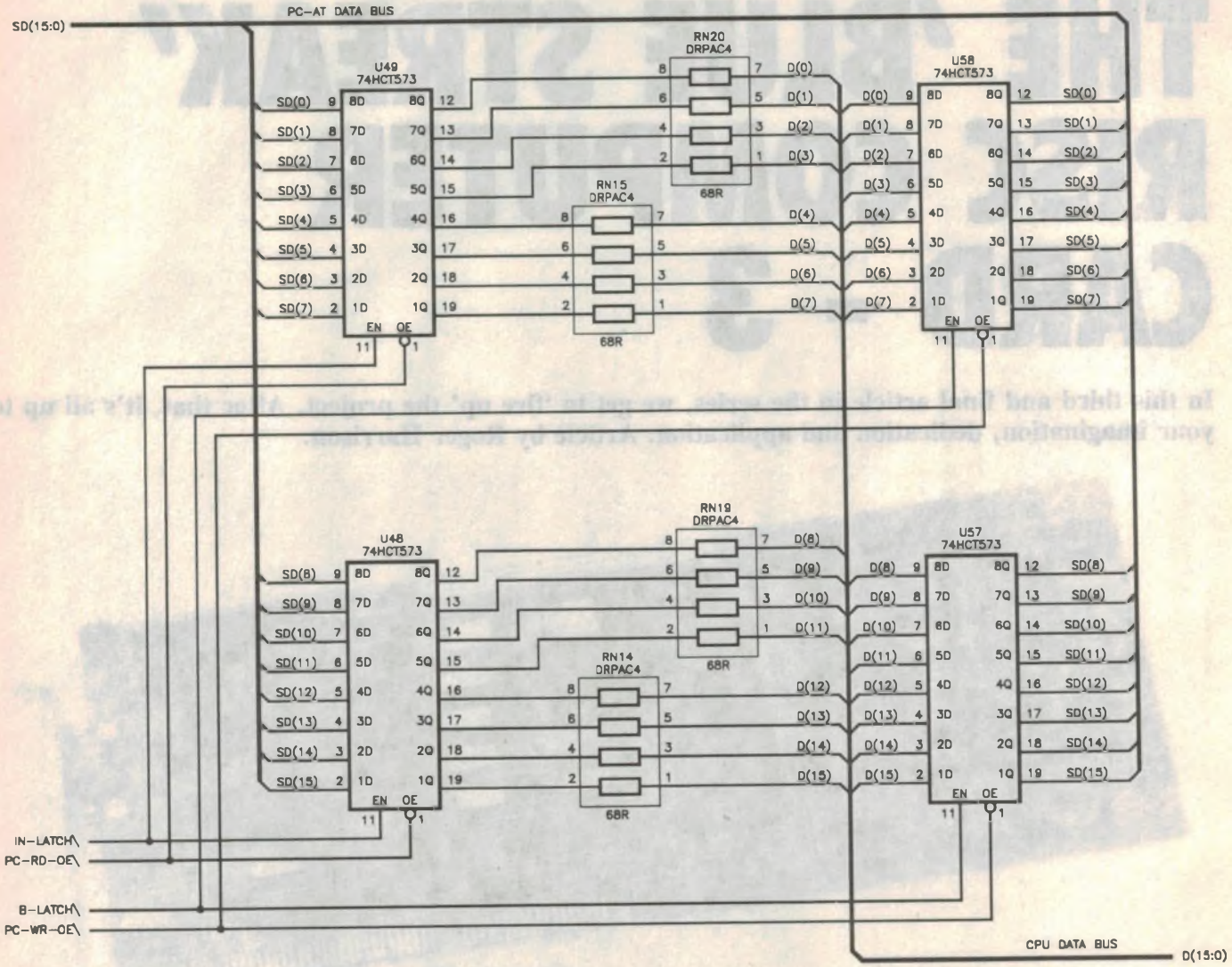
These LEDs are turned on by appropriate bits in the RISC's bus control I/O port. This port also contains several other bits that have a one time use during the bootstrap process, or during the bus master phase of communications with the PC/AT.

To the right and a little below these four LEDs is another, marked BUS BUSY. This LED is provided as a visual indicator of PC/AT bus activity. It is illuminated whenever the AT processor acknowledges that the Blue Streak has control of the bus; it is not directly programmable. It will light in response to a request by the card for the AT bus when bit 0 of the bus control port is set. The LED goes out when bit 0 is cleared and the AT hardware has resumed control of the bus.

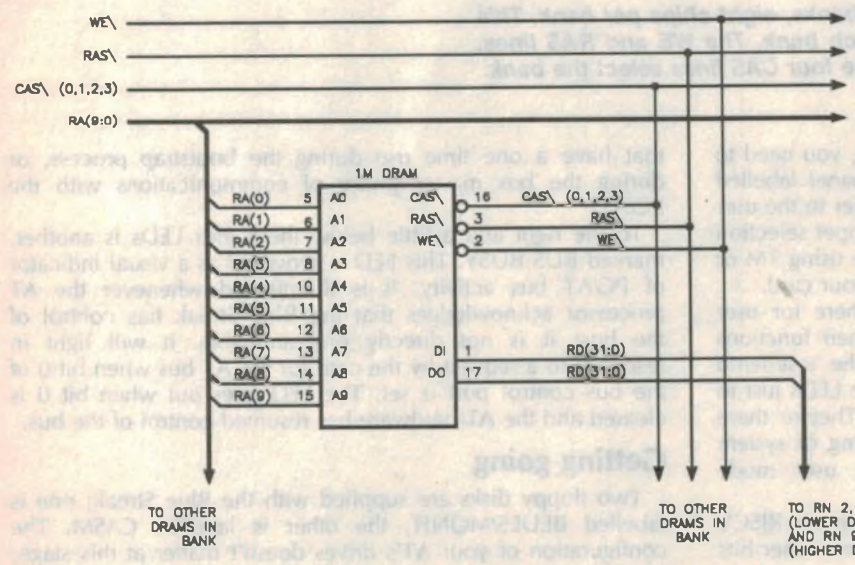
Getting going

Two floppy disks are supplied with the Blue Streak; one is labelled BLUES/MONIT, the other is labelled CASM. The configuration of your AT's drives doesn't matter at this stage;

ETI Project 1630 – 'Blue Streak' RISC Computer



PC-AT I/O LATCHES



The schematics above and below show sections of the circuit which couldn't be squeezed into earlier articles in the series.

only one floppy drive is necessary.

Load the Blue Streak card into a free slot. Leave the lid open so you can see the on-board LEDs. Boot your computer and go to the DOS prompt. Now, follow this procedure:

1. Put the BLUES/MONIT disk in drive A and type *A:*
2. Type *CD\MONT*
3. Type *BSI MONT*
4. Type *CD\BLUES*
5. Type *BLUES*
6. Type *CD\DEMO*
7. Type *LOAD DEMO2 7000*
8. Type *GO 7000*

If all is well, the group of four LEDs will *chase*.

If you have any difficulties, type *Ctrl C*, go to the *DEMO* directory and look at the *README* file. I know that sounds like reading the manual afterwards, but don't worry about it. There you'll find mention of another demonstration program, *DEMO1*. To try this out, just type *DEMO1* in place of *DEMO2* in step 7 of the above procedure.

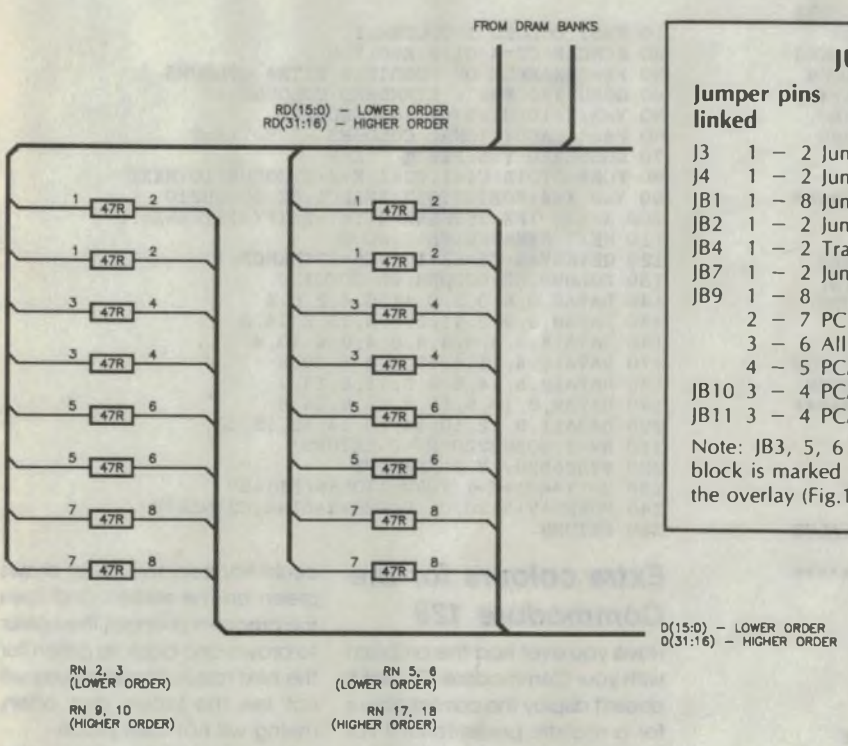
Note that there is also another *README* file in the root directory of this disk, which is concerned with user registration.

Epilogue

With your Blue Streak confirmed going, the rest is up to you. The Blue Streak User's Guide gives comprehensive instructions on commands and protocols, and other details. The CASM User's Guide provides a very thorough and comprehensive guide to using this programmer's 'tool set'.

Welcome to the world of RISC.

Contributed by The Apogee Group

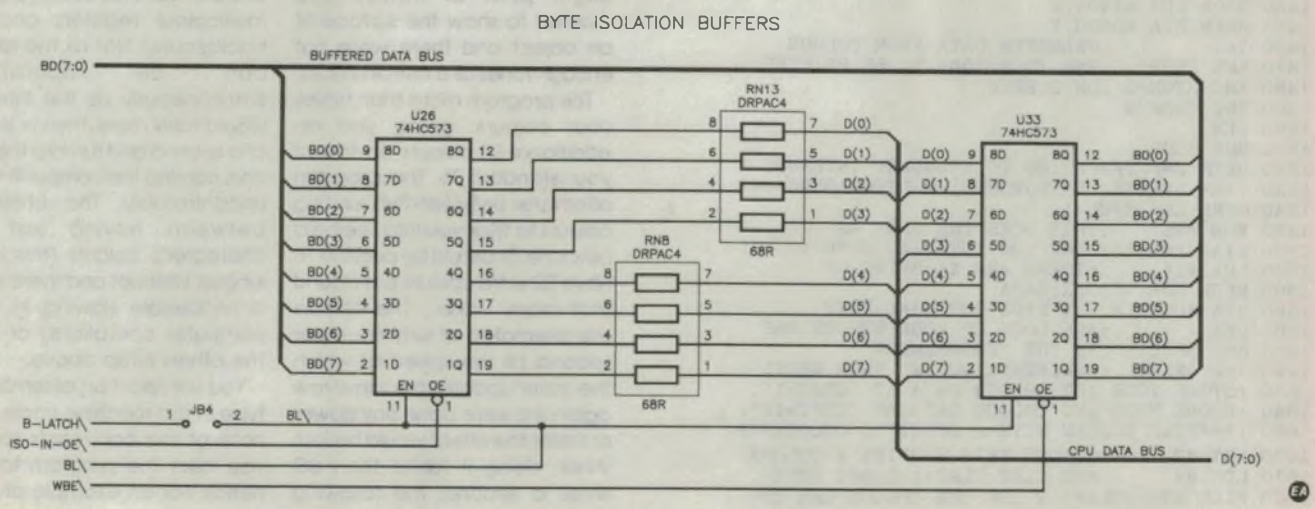


JUMPER CONFIGURATIONS

Jumper pins linked			Usage
J3	1	2	Jumper in for 256K or 512K EPROMs
J4	1	2	Jumper in for 512K EPROMs
JB1	1	8	Jumper in for 4M RAM; out for 1M RAM
JB2	1	2	Jumper in for internal clock
JB4	1	2	Transparent/Latched. Jumper for latched operation
JB7	1	2	Jumper in for PC/AT extended port address range
JB9	1	8	
	2	7	PC slave (RISC) port number
	3	6	All pins are left out
	4	5	PC/AT port addresses 0x100 and 0x102
JB10	3	4	PC/AT DMA request line select (DRQ7)
JB11	3	4	PC/AT DMA acknowledge line select (DACK7)

Note: JB3, 5, 6 and 8 are not used. Note that pin 1 on a jumper block is marked with a chamfer, in the corner of the block outline on the overlay (Fig.12).

Left and below are details of the bit line and byte isolation buffering.



INGENUITY

PROGRAM

```
1000 ;++++++EXTRA COLOURS FOR THE C=128.++++++
1010 ;*************DEFINE  LABELS*************
1020 *=$1300    ;THIS IS THE START ADDRESS
1030 IVEC=$314 ;INTERUPT VECTOR
1040 FLAG=$FB  ;PRESENT COLOR BANK
1050 CDAT=$1390;POINTER TO SPRITE,ETC. COLOURS
1060 CCR1=$14  ;THESE ARE THE HIGH BYTES TO
1070 CCR2=$18  ;THE CHARACTER COLOUR RAM BANKS
1080 ;THE LO BYTE IS ALWAYS $0. HENCE, COLOUR
1090 ;DATA IS AT $1400 (5120) AND $1800 (6144)
1100 ;THESE 2 GROUPS ARE SWAPED 60 TIMES/SEC.
1110 CLRP=$9E  ;TO SET ALL THE SCREEN TO ONE
1120 ;COLOUR, POKE CLRP/CLRP+1 WITH THE
1130 ;LO/HIGH BYTE OF THE COLOUR RAM.
1140 ;***********SETUP INTERUPT WEDGE**********
1150 SEI        ;SET NEW INTERUPT VECTOR.
1160 LDA #<WDGE
1170 STA IVEC   ;CHANGE 'WDGE' IN BOTH LINES
1180 LDA #>WDGE ;TO 'OTHR' FOR EXTRA SPRITE,
1190 STA IVEC+1 ;MULTI. & BACKGROUND COLOURS
1200 LDA #0     ;←THIS TELLS THE COMPUTER
1210 STA FLAG   ;WHAT COLOUR RAM IS TO BE
1220 CLI        ;DISPLAYED FIRST. ERASE IF YOU
1230 RTS        ;DON'T WANT CHARACTER COLOURS.
1240 ;*************TURN OFF WEDGE*************
1250 SEI        ;THIS ROUTINE INACTIVATES
1260 LDA #$65   ;THE INTERUPT. TO CALL
1270 STA IVEC   ;THIS ROUTINE TYPE,
1280 LDA #$FA   ;'SYS [VALUE OF *]+$11' OR
1290 STA IVEC+1 ;IF YOU ERASED LDA #0,
1300 CLI        ;STA FLAG (ABOVE)->'SYS [VALUE
1310 RTS        ;OF *]+$0C'
1320 ;*****CHARCTER COLOUR INTERUPT WEDGE*****
1330 WDGE LDA FLAG
1340 LDX #CCR1
1350 EOR #1
1360 STA FLAG   ;CHANGE COLOUR DATA RAM,
1370 BEQ SCNS
1380 LDX #CCR2  ;WORK OUT WHERE IT IS
1390 SCNS STX STOR+2;AND STORE IT
1400 LDA #$D8   ;←THIS IS THE HIGH BYTE OF
1410 STA CRAM+2 ;THE COLOUR INFORMATION
1420 LDY #0     ;SENT TO THE SCREEN
1430 LDX #4
1440 STOR LDA $1400,Y
1450 CRAM STA $D800,Y
1460 INY        ;TRANSFER DATA FROM COLOUR
1470 BNE STOR   ;RAM TO $D800+ TO BE PRINTED
1480 INC STOR+2 ;ON SCREEN
1490 INC CRAM+2
1500 DEX
1510 BNE STOR
1520 RETN JMP $FA65 ;GO TO STANDARD INTERUPT
1530 ;****SPRITE, BACKGROUND, MULTICOLOURS****
1540 OTHR LDA SPCL+1
1550 EOR #$E    ;THIS DOES THE SAME AS
1560 STA SPCL+1 ;'EOR'ING THE FLAG WITH 1.
1570 LDX #14    ;←THERE ARE 14 BYTES OF
1580 SPCL LDA CDAT,X;DATA.
1590 STA $D020,X ;TO FIND OUT WHAT THEY
1600 DEX        ;ARE LOOK UP YOUR MEMORY MAP
1610 BNE SPCL   ;IN THE 'PROGRAMERS
1620 JMP $FA65  ;REFFRENCE GUIDE' FROM $D021.
1630 ;STORE YOUR 1ST COLOUR DATA AT 'CDAT+1'.
1640 ;STORE YOUR 2ND COLOUR DATA AT 'CDAT+15'.
1650 ;***FILL SCREEN WITH A SPECIFIC COLOUR***
1660 LDY #0     ;TO USE THIS ROUTINE A=COLOUR
1670 LDX #4     ;AND CLRP/CLRP+1=LO&HI BYTE
1680 FILL STA (CLRP),Y ;OF THE COLOUR RAM TO
1690 INY        ;BE FILLED WITH THE COLOUR.
1700 BNE FILL   ;TO SET THE WHOLE SCREEN
1710 INC CLRP+1 ;YOU'LL HAVE TO CALL THIS
1720 DEX        ;SUBROUTINE TWICE FOR THE
1730 BNE FILL   ;TWO COLOUR RAMS.
1740 RTS

READY.
```

```
10 FAST:COLOR0,1:COLOR4,1
20 SCNCLR:C2=4:C1=8:X=0:Y=0
30 P$="EXAMPLE OF POSSIBLE EXTRA COLOURS."
40 GOSUB220:P$="- STANDARD COLOURS -"
50 Y=3:X=10:C1=5:C2=10:GOSUB220
60 P$="- ADDITIONAL COLOURS -":Y=7:X=9
70 GOSUB220:Y=5:P$="■ ":X=2
80 FORI=0TO15:C1=I:C2=I:X=X+2:GOSUB210:NEXT
90 Y=9:X=4:FORI=1TO37:READC1,C2:GOSUB210
100 X=X+2:IFX=36THENX=4:Y=Y+2:IFY=13THENX=15
110 NEXT:SYS4864:CB=1:SLOW
120 GETKEYA$:CB=CB+1:IFCB=17THENCB=1
130 COLOR0,CB:COLOR4,CB:GOTO120
140 DATA2,0,6,0,9,0,11,0,4,2,6,2
150 DATA8,2,9,2,11,2,5,3,13,3,14,3
160 DATA15,3,5,4,6,4,8,4,9,4,10,4
170 DATA10,4,11,4,12,4,8,5,10,5
180 DATA12,5,14,5,9,6,11,6,13,7
190 DATA9,8,10,8,11,8,12,8,14,8
200 DATA11,9,12,10,14,10,14,12,15,13
210 RV=1:GOSUB220:RV=0:RETURN
220 SYS65520,,Y,X:PRINTP$
230 S=(Y*40)+X-1:FORV=1TOLEN(P$)-RV
240 POKES+V+5120,C1:POKES+V+6144,C2:NEXTV
250 RETURN
```

Extra colours for the Commodore 128

Have you ever had the problem with your Commodore 128 that it doesn't display the correct colour for a realistic presentation? For example, for a skin colour the computer only shows grey and bright pink. Or maybe you wanted to show the surface of an object and there were not enough tones of a certain colour.

This program more than triples your colours, giving you an additional 37 colours on top of your standard 16. The program alternates between two existing colours to trick you into seeing a new one. (It should be possible to have 112 extra colours, but I found that many flicker.) The colours are alternated at sixty times per second, i.e the speed at which the raster updates the same row again. If it were done any slower or faster the effect would be lost. When doing it faster than 60 times a second, the following could happen: the raster draws green on the screen, and then the program changes the colour to brown and back to green for the next raster. Therefore you will not see the brown and, often, mixing will not take place.

The program does the character colours (which can also be two hi-res colours), sprites, multicolour registers and the background. Not all the effects can be operational simultaneously as the interrupt would take more than a sixtieth of a second and run into the next one, causing the computer to run uncontrollably. The choice is between having just the character's colours (this is the longest interrupt and there will be a noticeable slowing in other computer operations) or all of the others listed above.

You will need an assembler to type in the machine code. Take note of the comments to help you tailor the program to your needs. For an example of what

is possible, type in the basic program and run it with the machine code in memory starting at $1300. Press a key to change the background colour.

When you run the demo, you will notice the writing is in a non-standard colour. To write to the screen with ease, let P$ equal the message, x/y equal the x and y co-ordinates respectively, and C1/C2 equal the first and second colours to be mixed. Copy the subroutine starting at line 210 and jump to 210 if your message has reversed characters, otherwise jump to 220.

Shane Harper,
Lalor, Vic.

CIRCUITS

Servo mechanism

I needed a voltage controlled servo mechanism for use in a robot arm, to be driven by a computer D-to-A. Commercial servo mechanisms are expensive ($150) and the special pulses they need to drive them tend to gobble up processor time. This circuit is driven by a D-to-A output port that can produce a voltage of between 0 and 10 volts, or by a simple pot.

The motor and gearbox were taken from a $3.98 toy car. The shaft is connected to a nut which is screwed up and down a bolt. This bolt is then connected to the arm, acting in much the same way as a muscle. The feedback pot is connected to the joint and detects the position of the joint in space.

The circuit detects the difference between the desired position of the joint and the actual position. If the difference between the two is great, then the motor is turned on full and the joint moves to the desired position. In order to reduce overshoot, the drive to the motor is reduced as the joint gets close to the target value until the point at which the target and actual position are equal, whereupon no drive is applied to the motor. With the values shown, the circuit can drive motors with stall currents of up to 1 A, which is more than enough for small motors.

RV1 is the joint position sensor. RV2 is used to set the midpoint of the joint to correspond to half volts on the input. RV3 adjusts the gain of the position sense. It is adjusted so that the joint is, say, fully flexed at perhaps 6 V on the input and fully extended at, say, 4 V (with a 10 V supply). RV4 adjusts the gain of the error circuitry, and effectively controls how close the moving joint can get to the set position before it starts slowing down.

The output of IC1a is a voltage ranging from near the positive rail to near the negative rail, depending on the error. This is fed into IC1b which rectifies this error to produce an absolute error. This is fed into IC1c, which is a voltage-to-PWM converter. Potentiometers RV5 and RV6 set the input values needed to produce 0 V effective ranging to V+ effective volts out, respectively. IC1d controls the direction in which the joint must move to reach the desired position.

IC2 provides the necessary logic needed to drive the output transistors. Input 2 is optional, and enables the driver transistors when it is high. If it is not needed, it can be tied to the positive rail.

The two 1k resistors and the 10 uF capacitor divide the rail to provide half rail references. The motor should be run from a separate rail; three or four NiCads provide adequate speed for 1.5-3 V motors.

Setting it up is straightforward. The voltage readings here are for a 10 V supply. First, disconnect the power supply. Now set the position sense pot (RV1) to the mid position (i.e the joint to the mid position) and adjust RV2 so 5 V appears on the wiper of RV1.

Next, decide the input voltage range (e.g 3 V to 7 V). Disconnect the wiper of RV1 to the circuit and apply 3 V to the Vin input. Adjust the gain (RV3) so 7 V appears on the output of IC1a (IC1a is an inverter). Now reconnect the wiper of RV1 and move the joint so it is fully flexed, i.e the wiper of RV1 has moved towards the positive rail. Now adjust RV3 so that 5 V appears on the output.

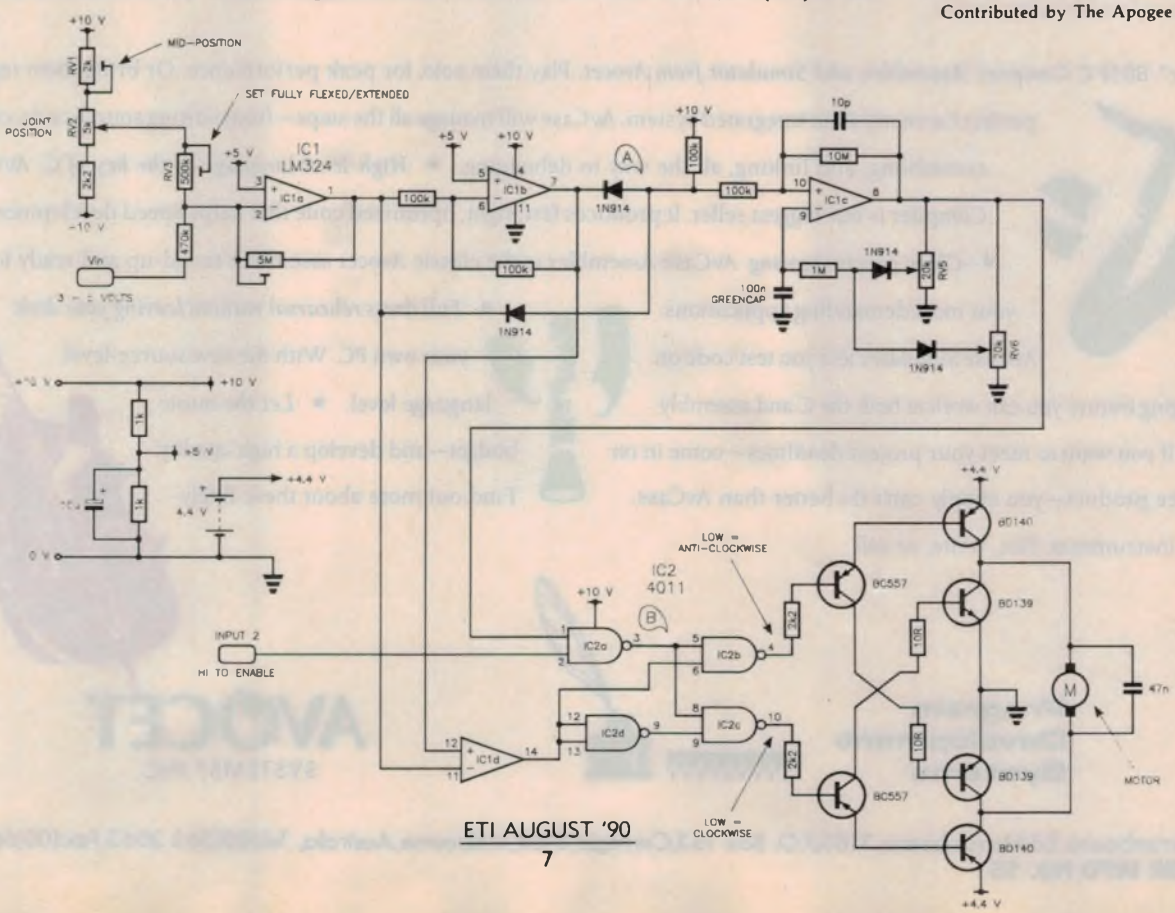
Next, measure the voltage at 'A' and adjust the Vin so that 3.6 volts appears here. Now measure at point 'B' and adjust RV5 so that B is just above 0 V (set it at the 0 V position).

Finally, set Vin so that 3.6 V appears at 'A'. Adjust RV6 so that 'B' is at or just below it. The gain (RV4) may now be adjusted so that the sensor responds quickly, but doesn't overshoot or oscillate.

James Moxham,
Urrbrae, S.A.

eti

Contributed by The Apogee Group



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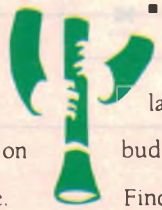

Program Development Systems

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READER INFO No. 15

WORKSTATION

EA/ETI'S COMPUTING SUPPLEMENT

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CD-ROM TECHNOLOGY: THE LIGHT FANTASTIC • BASICS OF MICROPROCESSORS - 4 • THE LATEST HARDWARE

CD-ROM: THE LIGHT FANTASTIC

After a slow beginning, CD-ROMs are gathering momentum as a data storage medium. Compared with magnetic disks, they offer many advantages – not the least being the ability to store over 500 times the amount of information on a disc roughly the same size as a standard floppy.

by GEOFF BAINS

It is rare these days to find a computer user who relies on cassette tape for data storage. Not only have cassettes all but vanished from the realms of serious computing, but the days of the floppy disk and Winchester hard disk may well be numbered too. All of these present day mass storage devices are based on magnetic material, and that is their downfall.

Enormous though the 20MB of storage available on a typical IBM PC/AT's hard disk may seem, it is not really large enough for the masses of information (especially high quality pictorial information) in common use on many computers today.

Personal computers with up to 4M bytes of RAM are becoming relatively common. Equipping these with a floppy disk drive which requires a handful of disks and takes several minutes to fill all of the computer's memory is more than a little ludicrous. Larger and faster permanent storage is needed.

The future of mass storage is not with magnetic media but with light – most often seen in the form of an audio compact disc or 'CD'.

Even at the simplest level, optical means of storing data are more efficient than the usual magnetic methods. The density of data from optical storage is much greater. You only have to look at a 35mm slide to see the kinds of densities possible – turn the idea around and imagine the disk space required to store a screen picture of that resolution.

The density of data in optical systems is finally determined by the wavelength of light itself (around one micron, or a millionth of a metre, for the light used). You can fit an awful lot of wavelengths into a small area, and so fit in a lot of data.

In comparison, the current densities possible with magnetic storage are limited not by the size of grains of magnetic material on the tape or disk (typically a few thousandths of an inch) but more by the size of the gap in the record/playback head. Even those miniaturisation experts, the Japanese, cannot manage wavelength-sized magnetic heads.

Many enclopedias are now available on CD-ROM, including Pergamon's International Encyclopedia of Education.

Of course, the practical methods of storing data optically do not come close to these theoretical densities, but already they get a lot closer than magnetic methods will ever manage.

The potential benefits of optical data storage have been known for some time and it was in 1967 that Philips engineers in Eindhoven in Holland came up with the start of a practical solution.

Their idea was meant for the storage of video and audio signals. A disc covered with marks detectable by reflecting a laser off the surface would be used. A disc was chosen as it was easier than a tape to move at a constant speed and could be stamped out in mass production.

The Philips invention turned into the *Laserdisc* video system. Although by 1972 Philips had demonstration machines on show and by 1978 (in the US) and 1982 (in Europe) the commercial machines were launched, the system could not stand up to the convenience of video cassette recorders and it has all but faded into oblivion. However, the Laserdisc was technically far superior to the VCR and had great potential, both for video and for storage of data.

The system uses tiny pits in the surface of a 300mm (12") disc, to modulate the reflected beam of light from a laser shining onto its surface as it revolves. The pits are less than a micron (1um) across, and arranged on a spiral track (like an LP) which makes about 55,000 turns around the disc, each track just 1.5um away from the next.

All this gives a data density of about 35,000 bits per inch – miles better than any magnetic media, and giving around ten times the capacity of any small Winchester.

Although the Laserdisc failed commercially, it served to develop solutions for the considerable mechanical problems of optical storage. The laser focusing lens reading the disc must be kept at exactly the right distance from the disc surface (within 0.25um) and the beam must follow the centre of the tracks to an accuracy of only 0.1um.

However such mind-blowing accuracies are obtainable, and the money invested in Laserdisc technology has found rich rewards for Philips and Sony in the CD. It is the audio CD technology that forms the base of a whole new standard of computer data storage – the CD-ROM.

CD-ROMs are in many ways similar to both standard CDs and the old Laserdisc. They use the same pitted surface technique for recording the data, but are just 12cm in diameter. The disc spins to keep the disc surface moving at a constant speed (about 1.3m/s) past the read head – so it must turn faster when the centre is being read (about 500rpm) than the outer tracks (around 200rpm).

The laser beam is focused on the surface and the reflections focused onto a photodetector, which can register a changes in light level as the pits spin past the lens. Each change of light level (the leading or trailing stepped edge of a pit) represents a binary 1 and the flat areas ('lands') in between represent 0's. Useful data comes off the disc at an effective rate of 153.6kbps – a bit faster than a floppy disk drive!

The data is encoded to reduce the effects of reading errors – whether from scratches on the disc surface or glitches in the system. At these data speeds it only takes an error rate of one in a 100,000 to produce errors more often than one a second.

Table 1
Comparison of computer mass storage

		Winchester	Floppy disk	CD-ROM
Media cost	(US$)	n/a	1-5	5-15
Drive cost	(US$)	500-3000	200-1500	500-2500
Capacity	(MB)	5-50	0.36-1.20	550-680
Media size	(cm)	13.34	13.34	12
Access time	(ms)	30-300	30-50	400-1000
Data density	(bits/in)	15000	10000	35000

The data must also be carefully identified to enable accurate random access to be performed on the disc – so the computer can read data from a section of the disc directly, without reading all before it. As a hangover from its audio CD roots, CD-ROM is addressed in units of 'playing time'.

The data emerges from the pickup as a serial bitstream. These bits are dealt with in lots of 588. First 27 bits of synchronisation data are stripped off. Of the remaining, 297 bits are then removed in a condensation process called 'Eight to Fourteen Modulation' (EFM). Since large long runs of zeros (flat areas) would cause the read head to wander, data is stored on the disc as 14-bit words, with only the 'best' binary combinations used and a further three bits are used to clearly separate each byte. The 33 17-bit words are condensed with EFM to 33 conventional 8-bit bytes.

One byte is a subcode byte containing positional information and is sent to a special decoder. Of the other 32, eight are CIRC error correction codes bytes. The remaining 24 bytes form the useful data 'frame'.

So far, CD-ROM is much like CD-Audio. However, there is much more stringent synchronisation and error detection used for CD-ROM.

The 24-byte frames are gathered up in 'sectors' of 98 – 2352-byte chunks. 12 bytes form more synchronisation data, four bytes are the header information (minutes, seconds and sector number), 2048 bytes are the final data and a massive 288 bytes form the complex error detection and correction data.

Each 12cm CD-ROM disc can hold 276480 sectors, or 540MB (megabytes) per disc.

The encoding against error detection is very complex, and closely follows the 'Reed-Solomon' encoding system used on audio CDs. As well as deriving checksum bytes for each frame of data (as do most digital cassette and floppy disk systems), this also involves interleaving the 24 bytes of data in each frame to split up any groups of bytes effected by errors (from, say, a scratch on the disc).

This system can successfully correct error bursts of up to 450 bytes long (which would be a clearly visible scratch

Hitachi's new CDR-1600S/1650S CD-ROM drives are available in both Hitachi bus and SCSI bus versions, and offer fast access time.

or mark). Combined with the additional error correction at block level (not found on audio CDs) the CD-ROM system has a rate of uncorrectable errors of just one in 10,000,000,000,000 – about one in every two years of constant accessing!

This kind of reliability has meant the CD-ROM is now taken seriously as a data storage media. Mainframe computers have been using large optical discs (not unlike the original Laserdiscs) for some time, and now CD-ROMs are entering the world of personal computers.

At the moment CD-ROM drives are available for IBM PC compatible machines and the Apple Macintosh. It will not be long before other computers get in on the act, and already drives for the Acorn Archimedes and the Commodore Amiga are under development.

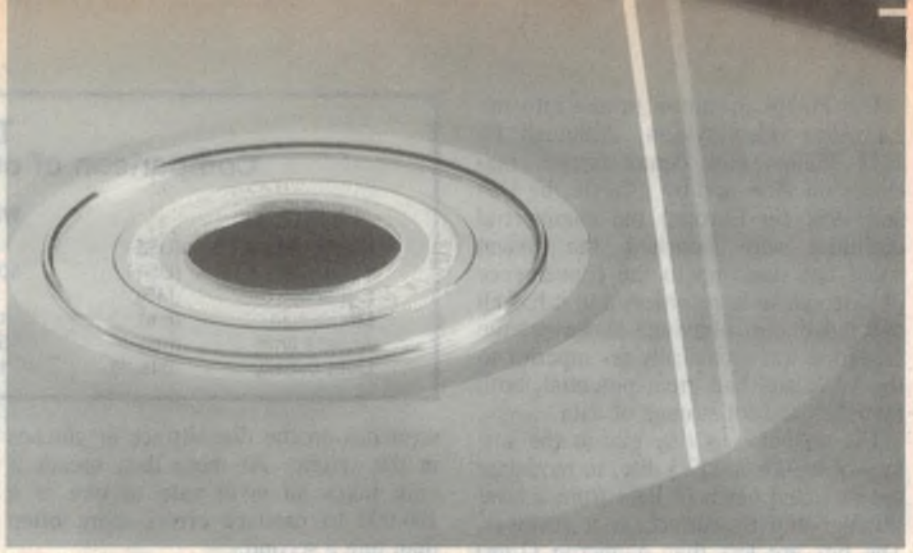
Hitachi is the main CD-ROM drive manufacturer at present, although drives from other manufacturers are also swiftly coming into use. A CD-ROM drive looks much like a floppy disk drive, but it loads a CD-ROM disc just like an audio CD player.

Microsoft has produced extensions to the MS-DOS PC operating system and the Macintosh operating system to accomodate the CD-ROM drives, and these are accessed by software much like a normal floppy disk drive.

Commercial CD-ROM data packages are now widely available. Microsoft's 'Bookshelf' was one of the first. This is a single CD-ROM disc providing 10 reference works for writers using PCs. On the disc are stored a comprehensive dictionary, a thesaurus, a business information listing, a literary syle manual and other useful tools for writers.

Any reference work is ripe for transfering to CD-ROM. Other products include a world atlas, the complete 18,500 page maintenance manual for a Boeing 757, all of the Sherlock Holmes stories, innumerable programmer's libraries, McGraw-Hill's 'Encyclopedia of Science and Technology', book and record catalogues, and even a list of details on every country in the world called 'The CIA Factbook'!

The 'software' can be very expensive. Some costs several thousands of dollars. However, when you consider the fact that each CD-ROM disc can store the equivalent of 1000 PC disks, that the CD-ROM drive and operating system often come free with the package, and you think of the time and resources to check the contents of up to 100,000 pages, it all seems more reasonable.



Announced in 1988, Tandy's 'Thor-CD' system allows repeated recording and erasure on CD compatible dye-based discs.

So reasonable, in fact that there are now estimated to be about 100,000 CD-ROM users worldwide, and that number is increasing all the time.

What makes CD-ROM so exciting, however, is not just the number of words you can put on a small disc – but what else you can put there too.

The discs are divided into tracks. Although just one track is all that's usually needed, many can be incorporated, each of a different format. So a disc could contain speech, music and video, all on one disc with complete computer access and intervention in their replay.

Inevitably, games get a look in, and the first is a graphics adventure game called 'Defender of the Crown', from the CD-ROM wing of the International Pergamon Publishers, featuring CD-Audio sound.

ICI's 'Digital Paper' also uses organic dyes, and comes as both tapes and discs.

More serious applications include a pronunciation disc to help foreign language students learn English.

However, although a great many reference works are now appearing on CD-ROM, therein lies the problem with the whole system. CD-ROMs are in one important sense just like semiconductor chip ROMs – they can only be read from, and not written to.

Once the information is stored on the disc (by mechanically stamping them out) it cannot be altered or erased. What would be so much more useful would be a 'CD-RAM' – a system with the same speed and capacities, but which could be written to by the computer just like a floppy disk or Winchester hard disk.

Writable optical storage discs have been available for about four years. Used only in research and large mainframes, these use larger 12″ 1-gigabyte discs with a thin coating of metal (only 0.05um thick) on the surface. As well as the usual low powered laser to read the disc, a second more powerful laser is provided which can melt tiny pits into the metal film surface to form the pits which store the data.

By modulating the powerful write laser with the data from the computer, these discs can be written to with whatever data needs to be stored.

A similar system uses organic dyes on the disc surface. These require less power from the write laser to alter their reflectivity. ICI has produced 'Digital Paper' which uses such dyes coated onto a flexible base, which can be used in the form of discs or even tapes. A 2400'

reel (an average 12" diameter spool) holding 600GB of data – enough to store three complete feature films in digitised form.

Honeywell has started to produce an optical tape recorder based on the digital tape. Japanese tape manufacturer Taiyo Yuden has announced a recordable audio CD based on similar principles. This is intended mainly for things like prerecording radio station output, but its application to CD-WORM is only a matter of time.

With all these systems, however, once the data pits have been formed in the metal or dye coating on the disc surface, there is no going back. The surface cannot be re-leveled or re-coloured and so the data is there for good. Such systems are called WORM drives – Write Once, Read Many times.

The enormous capacity of a CD-WORM means that room can usually be found for altered data, and the operating system instructed to ignore the outdated data on the disc. These systems find use in large databases for archive storage.

Various archiving systems are produced based on Digital Paper and CD equivalents. These are ideal backups for large computer network Winchester systems, compared to the old streaming tape system.

Truly erasable optical discs are still almost exclusively found in research labs. Two types are attracting the most attention. The first type uses a phenomenon known as the Kerr effect and a disc coating of gadolinium-iron-cobalt. This material has the effect of polarising light reflected from it in the same direction as it is magnetised.

The disc is first magnetised, and to write data onto it a powerful laser is used to heat the coating – which reverses the magnetic field at that spot. The reversal of polarised light from the read laser can then be used to detect the heated spot. The whole disc may then be erased of data by heating it again in a magnetic field to produce an evenly magnetised disc.

The second type of erasable disc uses coatings of a tellurium-selenium alloy or gallium antimonide. These materials have the property of changing their crystalline structure when heated, and this affects their reflectivity.

Again, a write laser produces hot spots of a temperature just above the melting point of the alloy coating on the disc surface, under the control of the computer. When the spots cool (almost immediately) they change their reflectivity and so allow the read laser to pick them up from then on. The whole disc can be erased by heating it to a temperature just below the melting point of the coating, whereupon the alloy reverts to its original structure.

Philips has produced reliable erasable discs using the gallium antimonide coating, which can be recorded and erased about 1000 times without degradation.

However, with both of these systems, data cannot be overwritten. These are 'CD-EPROMs' rather than CD-RAM. Much research is of course dedicated to finding a suitable material to use for CD-RAM.

A possible success has come from the most unlikely of sources. The Tandy Corporation (Radio Shack) announced a recordable, erasable CD back in 1988. Tandy reckons to deliver an audio CD recorder for US$500 this year, and a true CD-RAM system next year.

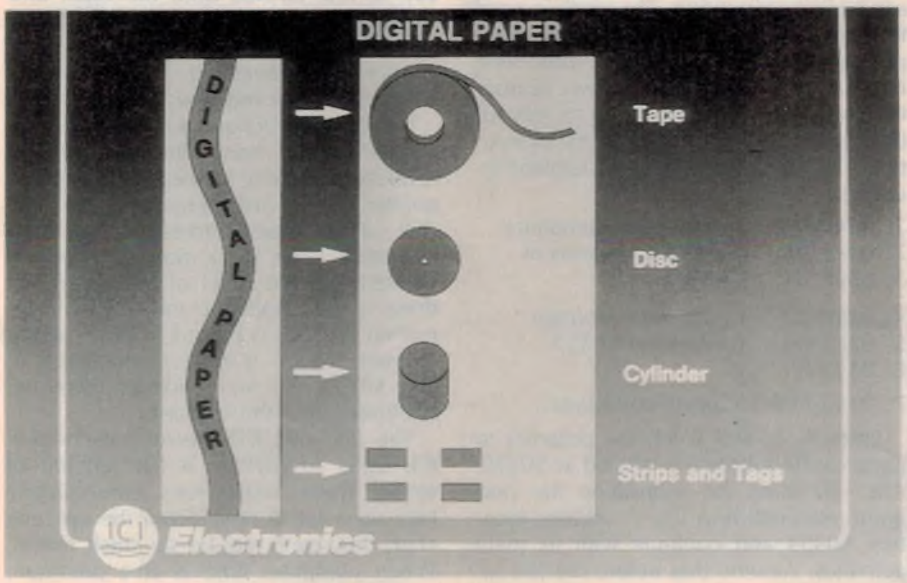
The Tandy 'Thor-CD' system is a dye based media and it is, Tandy claims, entirely compatible with existing CD technology and erasable and rerecordable almost indefinitely.

A German division of the French electronics giant Thomson has also announced a recordable, erasable CD. This time it's double sided, like a cassette tape, but still largely compatible with existing CDs. No expected date of a product launch has been given.

Whatever the future of CD-RAM, and it will certainly come one day, the future for optical storage is already set. With CD-WORM units containing several drives with a total capacity of several gigabytes, the necessity for overwriting ceases to be really important.

For small systems and even home computers, CD-ROM drives are on the increase and will surely be a commonplace sight before very long, even before alterability comes along.

The convenience and efficiency of vast quantities of data compactly and permanently stored and near-instantly accessible is too great a temptation for the personal computer industry to shy from for much longer. Then, of course, how about a 700 megabyte computer game, with hifi sound and video pictures...



In Part 4 of a five-part series, Elmo Jansz discusses sub-routines and interrupts, and examines logical operations.

THE BASICS OF MICROPROCESSORS

Most computers have a series of locations in Read/Write memory used for servicing subroutines and interrupts. In the Apple IIe, these are located in page one.

A subroutine is a program which can be used by a main program whenever required. An interrupt is similar, except that the MPU has to respond to a stimulus or signal from an external device and go through a service routine. In either case, the main program has to have a means of returning to the correct point at the completion of these secondary activities. The section of memory used for these is called the stack.

The stack is often referred to as 'first in last out' memory, because the first byte placed on the stack is the last one taken off; the stack is similar to a rack on which plates are stacked. All stack operations are controlled by an internal register called a stack pointer, which is eight bytes wide. We described the stack pointer in an earlier issue, when we examined the programmer's model of the 6502. The stack pointer contains the low order address of the next empty location on the stack. Since the stack is located in page one of memory, the high order byte of any address on the stack is understood to be $01. Fig.1 shows a portion of the stack.

Assume that location $0108 on the stack holds the byte $AA. The stack pointer decrements each time information is placed on the stack, and points to the next available empty location – $0107 in this case.

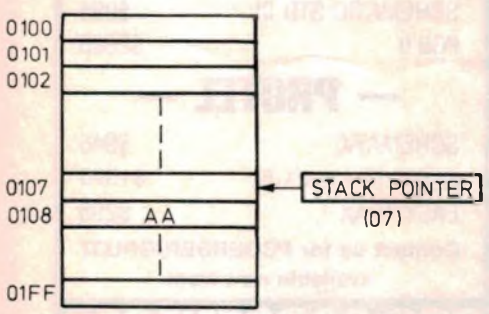


Fig.1: After a byte 'AA' is pushed onto the stack, the pointer is decremented.

Now suppose that the accumulator contains the number $BB and that this information is to be placed on – or, using the correct jargon, pushed onto – the stack. The mnemonic for this operation is PHA with op-code $48 and uses the implied addressing mode. When the PHA instruction is executed, the number $BB is placed in the location above that containing $AA and the stack pointer is decremented.

The new status of the stack is shown in Fig.2. Notice that the stack pointer now points to the next available location, namely $0106.

The reverse procedure takes place when information is pulled from the stack by the PLA instruction. When the MPU encounters the PLA instruction, it first increments the stack pointer. In this case the stack pointer now holds $07 and the byte $BB is transferred into the accumulator. A similar procedure takes place if $AA is to be transferred into the accumulator. After this, the stack pointer is incremented to $09 which is the next empty location.

Let us now examine the manner in which the stack is used by the MPU in servicing a subroutine. The stack is used to store the address to which the main program must return after the subroutine is serviced. The MPU uses two instructions to do this, the JSR (jump to subroutine) and the RTS (return from subroutine). The following program segment includes a JSR.

```
1. 034D 8D    ) Load the accumulator
2. 034E 03    ) with the contents of
3. 034F 04    ) $0403

4. 0350 20    ) Jump to subroutine
5. 0351 00    ) located at $0300
6. 0352 03    )

7. 0353 Main program continues...
```

Lines 4, 5, and 6 tell the program to jump to the subroutine located at $0300. After servicing the subroutine the program must return to line 7, address location $0353 and continue with its main activities. Assume that before the JSR instruction the stack pointer contained $B9 – see Fig.3.

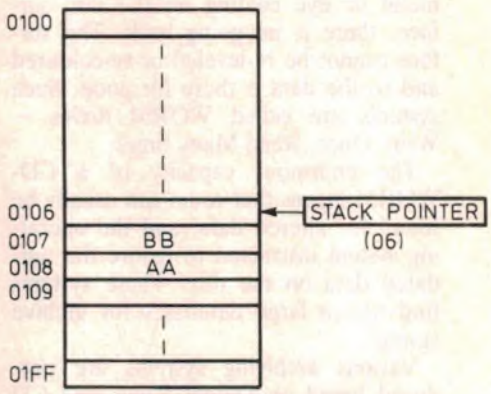


Fig.2: After a second byte is pushed onto the stack, the pointer is again decremented.

You can set the stack pointer to point to any location you wish, but this is not necessary as it will automatically use an empty location in page one.

The address of the third byte of the subroutine which is $0352 is pushed onto the stack before the MPU deals with the subroutine – see Fig.3. ADH = $03 is first pushed onto the stack and the stack pointer decremented. This is followed by ADL = $52 and the stack pointer is decremented. The MPU now deals with the subroutine.

The last instruction in a subroutine is the RTS (return from subroutine), which reverses the above procedure. The stack pointer is now first incremented and the ADL of the return address is read from the stack. The stack pointer is incremented and the ADH of the return address is read from the stack. This information ($0352) is placed in the program counter, which is then incremented to give $0353. The main program therefore, continues from this location.

The JSR and RTS instructions require the MPU to perform a fair amount of work. These instructions consequently take up a lot of time. From the op-code chart they each require six clock cycles. When computer time is at a premium,

subroutines should be avoided. When the computer is first switched on, the stack pointer has a random number in it. This does not lead to any problems since the stack has 'wrap around' facilities. That is, if the stack pointer if $00 and it is decremented, then its new value will become $FF.

The stack pointer can be set to any value by first loading the X-register with the desired value and using a TXS (Transfer X-register to stack pointer). This is an unnecessary procedure.

When the MPU receives an interrupt from an external device, the system has a routine built into it on how the interrupt should be serviced. The procedure is very similar to that in which a subroutine is handled.

Logical operations

The 6502 has facilities for carrying out both arithmetic and the following logical operations: AND, ORA, EOR, BIT, ASL, LSR, ROL and ROR.

The first three are defined as follows (assuming A and B are single bit binary numbers):

AND = AND operation – symbolised by A.B
OR = OR operation – symbolised by A+B
EOR = Exclusive – OR operation – symbolised by A⊕B

Not included in the above list is the complement or inversion which the MPU can also carry out. The complement of A is written as $\bar{A}$. Let us now examine the table below which further illustrates these points.

A	B	A.B	A+B	A⊕B	Complement	
0	0	0	0	0	A	$\bar{A}$
0	1	0	1	1	0	1
1	0	0	1	1	1	0
1	1	1	1	0		

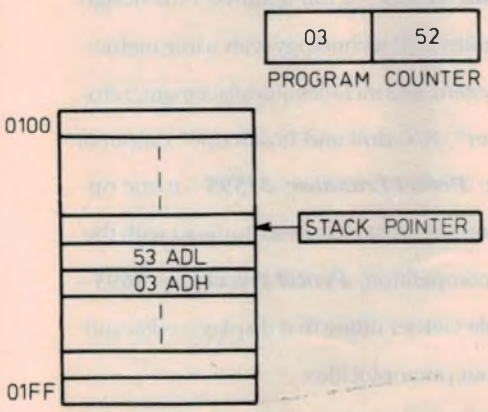


Fig.3: Before jumping to a subroutine, the return address is pushed onto the stack.

Observe that the AND goes to 1 only when both A and B are 1. The OR goes to 1 when at least one of A or B is 1. The Exclusive-OR goes to 1 when A and B are complements of each other. The last column shows the complement. This is the inverse of what we start with. The numbers A and B do not necessarily need to be one bit numbers. The 6502 is an eight bit MPU and deals with eight bit wide binary numbers. In this case, each of the above operations will be performed on a single bit basis.

Let us look at some examples:

Let A = $3A = 0011 1010
Let B = $F1 = 1111 0001
A.B = (0011 1010) . (1111 0001)

Rewriting the numbers one under the other:

0011 1010
1111 0001
0011 0000 = $30

ANDing $3A with $F1 gives us $30. Observe that any bit that was ANDed with a 0 was changed to 0 and any bit that was ANDed with 1 remained unchanged. Changing a bit to 0 while leaving others unchanged is called masking. The bits changed into 0's are said to be masked. The AND operation is shown on the op-code chart as A∧M→A. This means that the number in the accumulator is ANDed with the contents of memory location M and the result placed in the accumulator, replacing the original number that was there. You should now write out a small program segment to try out the AND operation and run it on your computer. For example, load the accumulator with $3A. AND it with $F1 and store your result in some memory location. This is the example we had earlier, and should have the same answer, namely $30. A solution should look like this:

```
LDA     #$3A
AND     #$F1
STA     $03D0
BRK
```

Assemble and run the program and examine location $03D0 for your answer. The OR-function can be examined in a similar manner.

Using the same values for A and B, i.e.:

A = $3A = (0011 1010)
B = $F1 = (1111 0001)

Rewriting the numbers one under the other:

0011 1010
1111 0001
1111 1011
F B

ORing $3A with $F1 gives $FB.

Observe that any bit that was ORed with a 1 gave a 1. The OR instruction can be used to change bits from 0 to 1 by ORing the appropriate bits with 1. This is useful for setting bits in a word.

The OR operation is shown on the op-code chart as A V M→A. This means that the number in the accumulator is ORed with the number in a memory location M and the result placed in the accumulator.

You should now write a small program to try out the OR operation. A program to OR the above two numbers should be as follows:

```
LDA     #$3A
ORA     #$F1
STA     $03D0
BRK
```

The exclusive OR of the two numbers A and B is determined as follows:

$3A = 0011 1010
$F1 = 1111 0001
A⊕B = (1111 0001) ⊕ (1111 0001)

Writing them one under the other:

0011 1010
1111 0001
1100 1011 = $CB i.e.,
A⊕B = $CB

Bits in a number can be complemented by executing an exclusive OR with a number whose corresponding bits are 1's. The bits are left unchanged by carrying out the operation with a number whose corresponding bits are 0's. Check this against the example given above. The exclusive OR operation is shown on the op-code chart as A∀M→A. This means that the number in the accumulator is being exclusive ORed with the number in a memory location M and the result placed in the accumulator.

You should now write a small program segment to check out the Exclusive -OR operation and run it on your computer.

The BIT instruction is very similar to the AND instruction except that the result is not stored.

The BIT instruction is shown as M∧M in the op-code chart. Note, there is no arrow to indicate that the result goes into the accumulator as we had with the AND operation. The logical values of bits 6 and 7 of the memory location accessed by the BIT instruction are placed in bits 6 and 7 of the P-register, i.e:

$M_6 \rightarrow V$ and $M_7 \rightarrow N$

The BIT instruction can therefore be used to modify the V and N flags in the P-register corresponding to the information in bits 6 and 7 of a location in memory.

Let us now examine the shift and rotate instructions. We shall first define each one of these operations.

ASL – Arithmetic shift left: each bit of the operand is shifted left.

Bit 0 goes into bit 1, bit 1 into bit 2 and so on. Bit 7 goes into the carry flag and a 0 is shifted into bit 0. A series of ASL operations is equivalent to multiplying by two, four, eight, 16, etc.

As an example $03 = 0000 0011.

After one ASL this becomes 0000 0110 which is 06_{10}. After a second ASL, the number becomes 0000 1100 which is 12_{10}, or $0C and is the result of multiplying the original number by four.

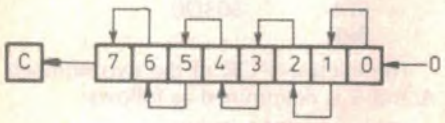


Fig.4: The operation of the 6502's 'ASL' instruction.

The ASL is indicated in the 6502 op-code chart, with the addressing modes available to it. Notice the last column indicates that only the N, Z and C flags in the P–register are modified by the ASL instruction.

LSR – Logical shift right: this is similar to the ASL concept that the bits are shift right.

A logic 0 is shifted into bit 7 and bit 0 is shifted into the carry flag.

A succession of LSR instructions is equivalent to dividing by two, four, eight, 16, etc.

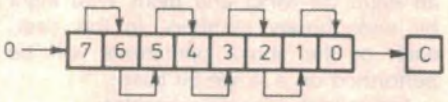


Fig.5: The 'LSR' instruction is equivalent to dividing by two.

Odd numbers will lose a bit when divided by two. The loss of bits by a series of right shifts destroys only the fractional part of the quotient and for some problems this may be acceptable. If this is not the case, software must be available to save the fractional part. Locate the LSR instruction on the op-code chart and observe that the flags involved in the P-register are still the N, Z and C flags.

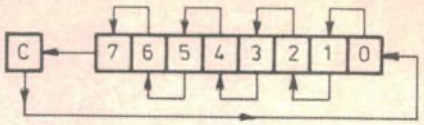


Fig.6: The operation of the 'ROL' or rotate-left instruction.

ROL – Rotate left. In this operation, each bit of the operand is shifted one bit to the left just like in the ASL. However, in this case the carry flag is shifted into bit 0.

A series of nine ROL operations will leave the operand and the carry flag in their original states. Identify the ROL instruction on the op-code chart and note that only the N, Z and C flags are modified by this instruction.

ROR – Rotate right. This is just like the ROL instruction except that the bits of the operand are shifted right. Bit 0 goes into the carry flag, and the carry flag is moved into bit 7.

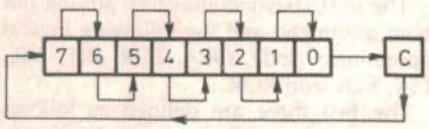


Fig.7: And finally, the operation of the 'ROR' instruction.

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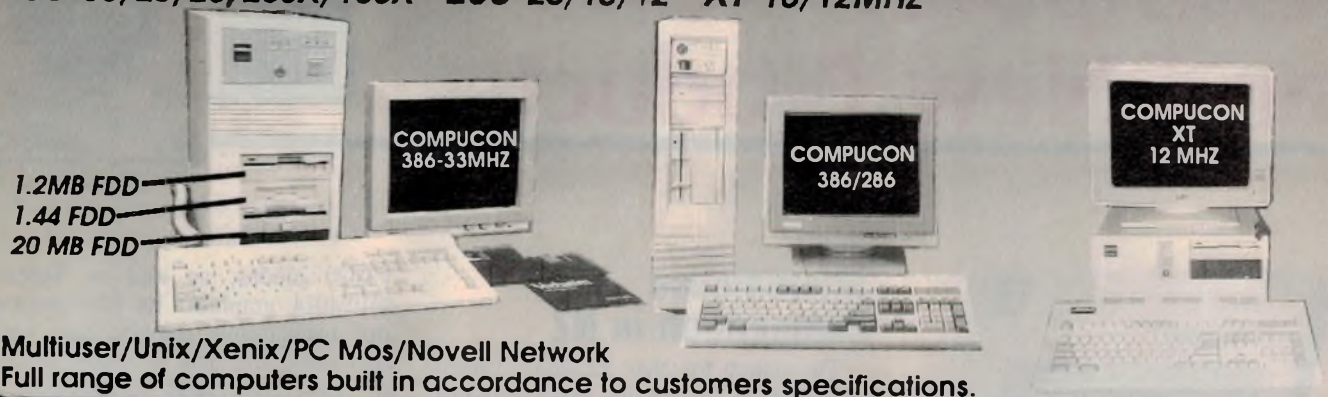

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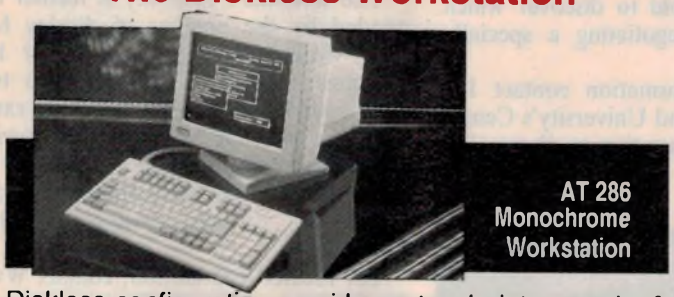

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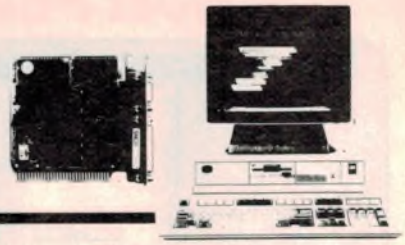


PC-driven gang/set programmer

The Logical Devices' 'Husky' is a gang/set programmer driven directly from an IBM PC via a plug-in card. It uses intelligent and quick pulse algorithms to program as many as four one-megabit EPROMs in less than three minutes. Each of the four 32-pin ZIF sockets supports gang programming of EE/EPROMS simultaneously with the same data, or sequentially with different data.

Devices supported include most popular CMOS, NMOS and HMOS EE/EPROMS and CMOS EPLDs. Single chip micros are also supported using an optional 40-pin expansion socket. Similarly, PLCC and PGA devices can be supported by additional socket adaptors.

The advanced software forms friendly user interface, which can be used under cursor or mouse control. There are no high voltages on the plug-in section of the programmer, eliminating the danger of damaging the PC in case of a programmer malfunction.

For further information contact Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

Micromouse competition in NZ

The search for New Zealand's smartest mouse is on. At this year's National Electronics Conference (Nelcon) in Auckland, rodents of the electro-mechanical variety will be put through their paces in a bid to discover which one is best at negotiating a specially built maze.

For further information contact Ian Cardno at Auckland University's Centre for Continuing Education or phone (09) 737 999.

High-performance colour terminal

Wyse Technology has announced a new high-performance colour terminal. The WY-370 is the latest in Wyse's 'Terminals of the 90s' series and is claimed to set a new performance standard in the general purpose terminal market.

The WY-370 offers a range of industry-standard ASCII and ANSI emulations, including WY-350 and DEC VT320 modes, as well as Tektronix 4010/4014 graphics. Its 64 foreground and background colours, and unique dual-sessioning and dual-host features, are made possible by its advanced Application Specific Integrated Circuit (ASIC) chip and a 16-bit MC 68000 microprocessor.

The terminal's flexiblity is further extended by the number of display formats available, up to 52 rows or 161 columns. It can be connected to two host systems, or two ports on the same system, and has advanced windowing capability, allowing the screen to be split, horizontally or vertically, to display two distinct sessions simultaneously.

For further information, contact Wyse Technology, 112-118 Talavera Road, North Ryde 2113 or phone (02) 888 7455.

Colour printer for the Macintosh

Hewlett-Packard has introduced the HP Paintwriter XL colour-graphics printer. This is HP's third colour printer that lets Macintosh users express themselves in colour at a relatively economical price (US$5600).

It prints a page of colour graphics in 1.5 minutes and has a dual Appletalk/RS-422A interface.

The inkjet printer has automatic sheet feeding of transparency film and paper for high-volume printing and networking needs, and handles letter (A/A4) and tabloid (A3/B) media sizes. It has a simple front panel and platinum case typical of Macintosh printers.

Macintosh users now can choose from the HP Paintwriter XL, or the HP

Paintjet and HP Paintjet XL printers with the HP colour Printkit for Macintosh computers. With these products, they can create colour desktop presentations, desktop-published documents and spreadsheets.

All of these printers support 32-bit colour Quickdraw. They offer background printing – spooling capability in the software driver allows customers to use their computers while the printer is operating.

For further information contact Hewlett Packard on (008) 033 821.

AT motherboard for old PCs

Electronic Solutions has just released a high performance 12MHz/0 wait state PC/AT motherboard that fits into pretty well every old PC and AT case on the market. It is useful where there is a need to upgrade an older machine, or where a compact (and low cost) AT motherboard is needed, with good expansion potential.

The board is based on the high performance Texas Instruments PC/AT 3-chip set. The motherboard is half size, yet has five 16-bit slots and one 8-bit slot. The size is 8.6" x 8.6". The onboard memory is 1MB or very fast (80ns) RAM. Speeds available are 8 or 12MHz with 0 or 1 wait state, so the board can be used with slower memory chips if required. Switching can be done from keyboard or via jumpers on the motherboard.

The motherboard achieves higher performance than other designs by the use of an innovative 'advanced bus'. This caters for users with a mixture of slower peripheral cards and newer 'fast slot' cards that can work at higher bus speeds. The motherboard caters for all these cards by using dynamic I/O speed control. This switches the system clock to 8MHz for I/O instructions or off-board memory access. In addition, appropriate wait states can be added to I/O channels either in dynamic or non-dynamic mode.

The ROM subsystem consists of two 64K by 8-bit ROM/EPROM sockets and is housed in two 16K by 8-bit ROM/EPROM modules organised as 16K by 16-bit.

For further information contact Electronic Solutions, 5 Waltham Street, Artarmon 2067 or phone (02) 906 6666.

Autotrax upgraded

Protel Technology has released an upgraded version of its popular Autotrax printed circuit board design package for IBM-PC (R) and compatible computers.

Designated Version 1.5, the new version features a switchable metric/imperial grid system that supports a mix of metric and traditional imperial components. A true metric grid is now provided, not just a coordinate display. Both metric and imperial dimensions are generated and displayed for all design elements, such as tracks, pads and holes. The designer can toggle between metric and imperial measurement at any time during board layout.

Designers can now automatically include curved transitions when manually routing connections. Curved tracks are of special benefit to analog and high-frequency designs. This feature is also supported in the autorouter, where an Arc Replacer option automatically smooths 90° corners into arcs on routed PCBs.

Autotrax now also generates automatic solid polygon fills for either the top or bottom layer of a PCB. These solid fills 'wrap-around' existing tracks and pads, and allows the designer to leave solid copper conveniently positioned wherever additional shielding is desired.

Autotrax's V1.5's autorouter has been re-written to improve both completion rates and route quality for most designs, including single-sided and SMD technology applications. Support is now provided for VGA graphics displays up to 1024 x 768 resolution.

The Print/Plot utility has been re-written to improve output quality and efficiency, with particular emphasis on improved Gerber (R) plot generation. New drivers have been added for Epson LQ (TM) and compatible 24-pin printers.

The upgrade to V1.5 is available free of charge to all registered users.

For further information contact Protel Technology, GPO Box 204, Hobart 7010 or phone (002) 73 0100.

Autodesk Expo'90

Autodesk Expo '90 is to be held from August 8-10 at the World Congress Centre, Melbourne. The three day conference and exhibition will highlight the latest developments in the CAD, CAE, three-dimensional modelling, interactive design, graphics software and related industries from Australia and overseas.

For further information contact the Expo Secretariat on (03) 698 4210 or call toll free (008) 033 148.

COMPUTER NEWS & NEW PRODUCTS

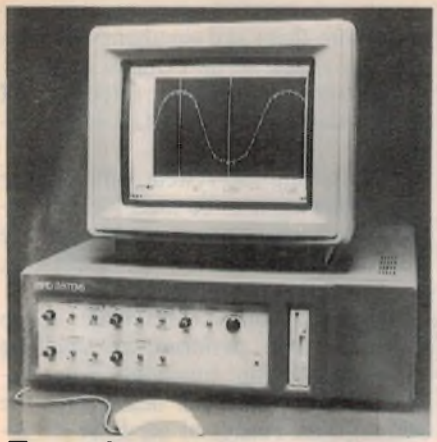
Industrial label printer

Facit's high speed T9700 label/bar code printer is specially designed for heavy-duty industrial use, providing high-quality bar codes, graphics, variable text and OCR on up to 256mm wide labels or tags and combines complete label design capabilities with modern industrial labelling requirements.

The printer can accept either thermal paper (direct thermal printing) or ordinary label paper (print ribbon thermal transfer printing), to create in seconds, labels that would take almost a minute on normal scanning matrix printers. Print speed is rated at 50mm/sec.

For computer communication, the printer is equipped with RS-232-C serial, and Centronics parallel interfaces, and has an advanced set of instructions for label creation which covers a library of bar code types such as EAN, UPC, Code 39, and variable text. This means labels and tags can be easily created in batch mode or on-demand mode.

For further information, contact your local Elmeasco Instruments office or phone (02) 736 2888.



Transient waveform analyser

Rapid Systems has introduced the R1250 transient waveform analyser. This uses the power and flexibility of an AT personal computer to provide four independent, 1MHz, 12-bit analog to digital converter channels.

A large 256K waveform data buffer provides up to 64K data buffers for each channel. Colour VGA display provides resolution for the mouse/menu driven instrument interface software. Four independent channels each with programmable gain allow multi-channel recording of applications like biomedical instrumentation, transducer output analysis, transfer function measurements, and data acquisition systems.

For further information contact Warburton Franki, PO Box 14, Lidcombe 2141 or phone (02) 648 5455.

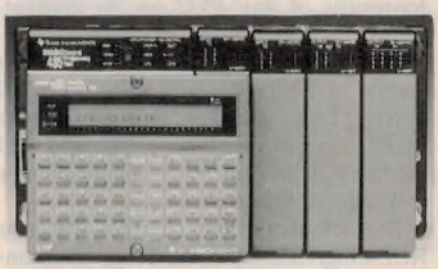
High speed EPROM programmers

Advin Systems 'Sailor' range of EPROM programmers represents a significant advance for this type of instrument. Each unit is directly controlled by an IBM-PC/XT/AT/PS2 or compatible computers.

The units are fast and intelligent. They may be operated in the 'set' or 'ganged' mode. It does not use the slow RS-232 type of communication, but has been designed to interface with the PC through the standard parallel printer port. A 'virtual memory' feature makes use of computer RAM and disk space. RAM expansion modules are never needed, even for high capacity PROM's.

No serial downloading is required between the PC and the programmer. Devices may be programmed all the same or set to burn different data simultaneously into each device. The Sailor Systems support all programming algorithms – standard, fast and quick pulse. With its software it is portable to any machine that has the standard parallel interface. There is no interface card to remove or install.

For further information contact Kenelec, 48 Henderson Road, Clayton 3168 or phone (03) 560 1011.



New PLC and free software

Texas Instruments has announced a brand new TI405 PLC and a free software offer for its recently launched 305 Controller, which is a direct replacement for the GE Fanuc series One.

Anyone purchasing the TI305 PLC,

which retails for approximately $379, will also receive free software that allows them to convert easily and conveniently from Logic Master to Tisoft.

The TI305 PLC has an input/output capacity of 24 to 168 points including digital, analog and intelligent input/output. It maintains one of the smallest footprints of any PLC on the marketplace.

The 405's scan speed was found to be fastest in a comparison with over 180 other PLCs. Besides multiple colour LEDs are provided on CPU and I/O modules as well as 96 descriptive error messages to locate problems.

The 405 uses either Machine Stage or RLL diagrams. Machine Stage programming offers faster programming and increases functionality yet requires only a few simple commands to operate. It is also claimed to make debugging easier.

Both the 305 and 405 product families are part of TI's full line of automation controls, ranging from the basic and complex machine, to cell/area control with TISTAR and production line/plant control through the TI D/3 distributed control system and S/3 Supervisory Control and Data Acquisition (SCADA) system.

For further information contact Texas Instruments Australia, 6-10 Talavera Raod, North Ryde 2113 or phone (02) 887 1122.

PC compatible frame grabber

The AES VDIGI frame grabber adds real-time image acquisition, processing and display to the range of IBM PC, XT, AT, 386 and compatibles.

It will capture video signals from real time, store them and simultaneously display the image on an external monitor. If real colour is required, three VDIGI boards will provide an RGB input/output.

This imaging sub-system will enhance a PC, allowing it to be used for new applications such as robotics vision, image archival, automation quality inspection, graphics resolution and many others.

The board comes with menu driven software which performs all grabbing and manipulation functions. The on-board video buffer fits neatly into the 64K segment barrier of the IBM PC architecture. This feature results in a more versatile, cost effective and faster capture and most importantly, faster, cleaner image processing code.

The ability to capture an image and transfer it quickly to the PC system RAM, provides a greater increase in analysis speed for high-end users, removing the I-O bottleneck.

The cost effectiveness of the VDIGI opens it up to a wide range of potential users – from the professional designing an OEM system to the serious enthusiast.

For further information contact Adept Electronic Solutions, 30 Charles Street, Bentley 6102 or phone (09) 451 2665.

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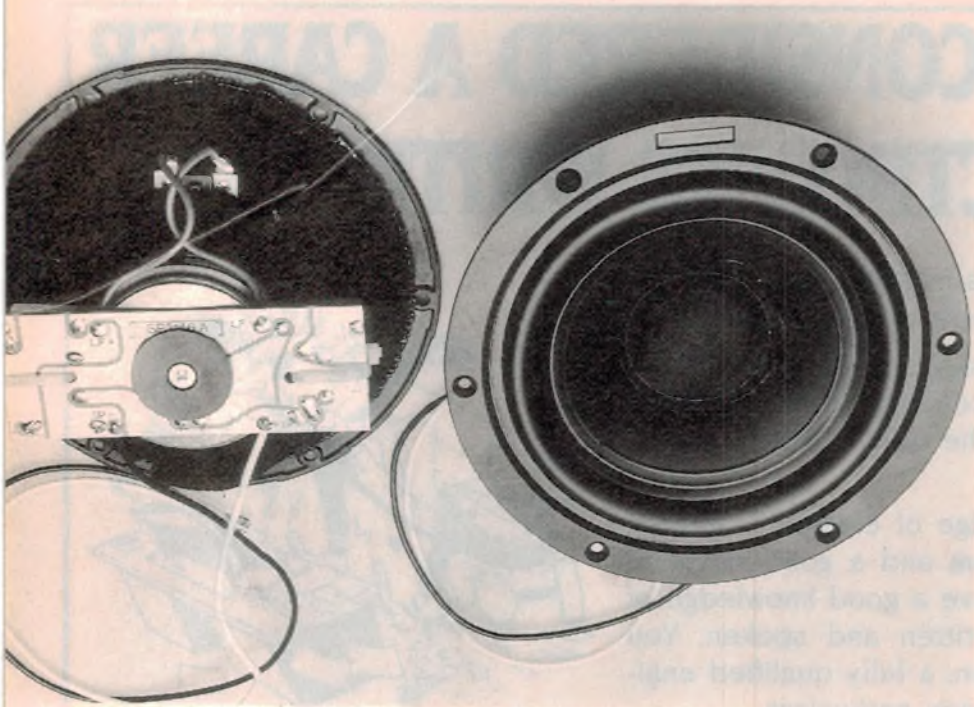


CHECKING OUT KEF'S INWALL 'UNI-Q' SPEAKER

So keen was Louis Challis to try out the CR160 custom 'in-wall' version of KEF Electronics' new 'UNI-Q' coaxial/coplanar loudspeaker driver, that he cut a hole and mounted it in the door of his anechoic room. Later he also tried out a pair in the saloon of 'Pixie', a luxury 11.5m yacht – is there no end to his dedication?

KEF's position as one of the world's leaders in speaker technology has been built on a solid foundation of basic research into acoustics and the optimum perception of reproduced sound. Some of you may already be aware of the work of their technical director, Laurie Fincham who developed the computerised 'Decay Response Analysis Procedure'. This is now generally acknowledged as the most outstanding technical breakthrough in the 70's, as it provided us with the first objective test procedures through which we could obtain direct correlation between objective testing and how a speaker sounds. Over the last 15 years KEF's R&D programmes have continuously expanded their horizons, particularly in the area of subjective perception of amplified sound.

Some of their more recent technical advances (some people would describe them as breakthroughs) have included the KEF 'coupled cavity bass system', for improved bass response from small speaker enclosures, as well as their development of the 'Conjugate Load Matching Networks', which in effect doubles the power output of most amplifiers used with their reference speaker systems.

Most recently, and significantly in terms of this review, they have developed the 'UNI-Q' Driver Technology, which places a tweeter at the centre of a wide range (low frequency) speaker diaphragm. This particular development is one of the first fruits of their research into speaker-room interactions, and the concept has been further refined during an extensive R&D program called 'Project Archimedes' – in which KEF combined resources with those of Bang & Olufsen, for a wide ranging and comprehensive three year study of psycho-acoustics at the Technical University at Lyngby in Denmark.

Many of you may well have found memories of an earlier generation of Tannoy dual concentric coaxial speakers which were in vogue around 30-40 years ago. The underlying concept of those speakers was to provide a true wide range 'point source' speaker system, to optimise stereo imaging for both professional and consumer sound amplification systems.

Whilst the Tannoy (and other) coaxial speakers resorted to short flairs on the extended voice coil, or even adopted miniature tweeters mounted on a bracket in front of the voice coil dome, the KEF UNI-Q driver system has followed the concept which Technics initiated in their SBR100 series speakers, and has positioned the tweeter right in the middle of the mid-range driver's voice coil magnet assembly.

The UNI-Q driver utilises an unusual miniature domed tweeter with a miniscule neodymium iron/boron alloy magnet assembly, whose magnetic properties are claimed to exceed almost all conventional magnetic materials previously developed for commercial applications.

By placing the UNI-Q tweeter right at the centre of the associated speaker's magnetic circuit, and by correctly shaping the diaphragm of the adjacent driver, KEF have been able to provide what they claim to be the most outstanding dual coaxial speaker on the market.

A significant part of the 19mm diameter tweeter's superior performance has been achieved by winding an unusually lightweight voice coil on an extremely thin and equally light aluminium former. To compensate for the reduced thermal inertia (and thus for

its reduced thermal dissipation capabilities) they have added a 'Ferro-fluid' which not only enhances the heat dissipation characteristics of the tweeter by almost an order of magnitude, but more significantly (as they found), provides substantial transient damping to minimise ringing at the cessation of transient peaks.

"Very interesting," you say – "but I don't want to spend thousands of dollars on a Reference Speaker System!"

Well, KEF also realised that, and to many reviewers and quite a few of their competitors' surprise, they decided to enter the lucrative 'Architectural Audio' market with a brand new speaker.

They decided that they would be capable of capturing a significant share of this burgeoning market, which has already attracted some mighty strong and equally innovative competitors. Foremost amongst these firms in the USA are Sonance and Boston Acoustics, and there are a number of smaller firms – most of whom appear to be 'one trick ponies'.

There are many people who want a high quality loudspeaker which they can build into walls, or which are designed to 'customise' into their new and expensive furniture. There are others who want speakers to recess into ceilings, or loft spaces, into walls of caravans or even place in the bulkheads of boats. These speakers should be capable of providing a level of performance which is hopefully on a par with a conventional hifi system, instead of sounding like a cheap loudspeaker in a lift car, and certainly better than those in a cheap transistor radio.

KEF's investigations confirmed that with a built-in loudspeaker, there are a series of psycho-acoustic and practical construction related factors which call for the smallest possible size of cut-outs you need to make in a wall, bulkhead or ceiling in which a 'built-in speaker system' is to be installed. Unlike some of their competition, from the outset they set out to simplify the fabricators' tasks as much as possible and obviously without sacrificing technical performance.

Realising that these speakers would be installed in a wide range of potentially inclement (or in some cases even hostile) environments, they opted for a water resistant polypropylene cone and for an all metal voice coil for the low frequency driver.

To achieve maximum rigidity and to compensate for anticipated deficiencies in the future mountings (over which they would have no control), they chose a robust cast-aluminium speaker basket support frame. This ensures a stable long term axial alignment between the voice coil and the magnet assembly. To simplify the system installation even further, the integral cross-over network is mounted directly on the rear of the woofer magnet. This has been combined with a tweeter protection network which reduces the tweeter drive voltage when excessive high frequency voltage is applied.

As I found, the cross-over and protection circuit provide a practical separation element which minimises possible contact of loose elements within the space in which the speaker is to be mounted. Further protection for the speaker diaphragm is provided by a neatly fitted cloth cover over the back of each speaker, which inhibits the entry of insects, metal particles or other debris which

Above: the construction of the UNI-Q driver, with the tweeter voicecoil very close to coplanar with the bass voicecoil (as well as coaxial). At right: installing a driver in Pixie's saloon.

Challis on KEF's 'UNI-Q' driver...

tends to shorten the life of most speakers.

Overall dimensions of each speaker are 220mm (square of diameter), and 89mm deep. Each speaker is terminated in a pair of 300mm long colour coded leads, each of which is terminated by polarised quick release automotive type covered connectors – making electrical connections to the speaker both simple and straightforward. KEF also provide a matching pair of connectors so that your cables may be quickly and conveniently extended and terminated with minimum complication.

Realising that the purchaser will have distinct and individual taste, they supply a pair of speakers in one box, and you may then choose either a pair of circular or a pair of rectangular bezels with matching perforated white grilles. These push-on grilles ensure adequate protection and offer reasonable durability under most (but not all) practical working conditions.

Having learnt from their competitors, the grilles sensibly incorporate an acoustically transparent, but visually opaque polyester cloth screen which hides the presence of the supplementary mounting elements. The literature provided with the grilles claims that they may be sprayed to suit specific decors, and that the polyester cloth may also be sprayed or dyed to match; but I did not put it to the test. To top it off, as well as providing cutting templates, 'rough-in' frames of glass reinforced plastic polymer are also available for new constructions – which is very sensible. And as I subsequently discovered, they have also developed a matching optional built-in sub-woofer system which extends the low frequency response down to well below 40Hz.

Checking it out

When it came to testing the CR160 speaker, we first decided to mount it in a panel in the doorway of our anechoic room, to duplicate a wall or celing mounting system.

This turned out to be most complex and proved generally unsatifactory from a standardisation point, not only because of the way the panel was installed in the anechoic room's only doorway, but also because the guy who cut the main panel had opted for a panel with dimensions of one metre square. The same member of staff placed a supplementary panel immediately below the test panel so that we could gain access into the room and of course this meant crawling on hands and knees each time a change in the test procedure was required!

Although the test set-up was far from perfect, I decided that because many (if not most) of the situations in which these speakers are likely to be used, would be far from optimum, then this test procedure would at least be realistic. As it transpired, this approach proved to be an acceptable compromise, and the measured on-axis frequency response extended from 60Hz to 18kHz with two significant measured notches, one of which lay in the 80Hz region, whilst the other was around 9kHz.

As I was concerned that the panel test might have introduced unwanted errors into the testing, I repeated the test with the speaker mounted in a 30 litre vented enclosure to reassess the performance and specifically to see if the two notches were still there. As you will see, the notches weren't artifacts from the test procedure, as the vented enclosure produces very similar characteristics. These notches are apparently interference effects, associated with position of the UNI-Q tweeter in the throat of the low frequency driver's diaphragm assembly.

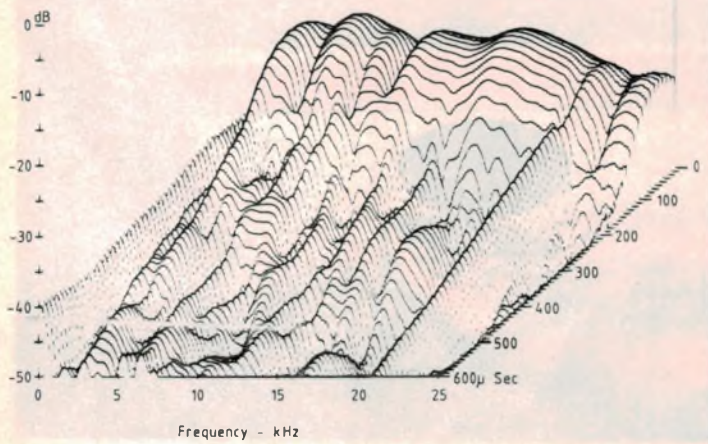
It proved easy to measure the speaker impedance curve, which was extremely smooth apart from a single resonant peak at 60Hz, but it proved extremely difficult and a most unrewarding exercise when we tried to measure the phase response in the square panel. Surprisingly, apart from the two major reversals in the phase response, which were directly attributable to the non-sealed mounting system, those measurements still confirmed that the phase response is still very smooth and that the UNI-Q system provides a generally good linearity apart from 'funny interference problems' which were observed in the 10kHz region.

The harmonic distortion measurements revealed a relatively high level of 7% distortion at 100Hz, a somewhat lower level of 1.2% at 1kHz and a very low level of only 0.17% at 6.3kHz.

Not surprisingly the CR160 speaker requires just under 13 watts of power to produce 96dB of sound pressure level, at one metre on axis in the panel test. This is quite reasonable when you consider the nature of the inefficient mounting system that we chose for our first frequency response testing set-up. It will also be typical of many, if not most, of the potential systems in which these speakers are likely to be used.

Although we had intended to produce a decay response spectra analysis in the panel, this could not be achieved with the original testing set-up so we repeated

Below is the decay response spectrum analysis plot of a UNI-Q driver in an enclosure.



Measured Performance of KEF CR160 Loudspeakers

Serial No:	005814			
Frequency response: (on 1m x 1m baffle)	As Fig.1			
Sensitivity: (for 96dB average at 1m)	8.8V/rms = 12.9 watts (nominal into 6 ohms)			
Harmonic distortion: (for indicated levels at 1m) on 1m x 1m flat baffle		**96dB 100Hz**	**96dB 1kHz**	**90dB 6.3kHz**
	2nd	–23.2	–41.2	–56.0dB
	3rd	–40.9	–41.3	–63.9dB
	4th	–45.4	–66.6	-
	5th	-	-	-
	THD	7.0	1.2	0.17%
Input impedance One Test			**100Hz/7kHz 4:1**	
	100Hz		6.6 ohms	
	1kHz		5.6 ohms	
	6.3kHz		5.4 ohms	
	Min at 2kHz		5.4 ohms	

the test with the speaker installed in its supplementary speaker enclosure. That testing proved to be worthwhile as it confirmed that the decay response spectra of the speaker still has its notches, has a significant mid-range presence, and exhibits two prominent decay resonances – one at 3kHz and the other at 20kHz.

I had hoped to install the speakers in a ceiling in my home, but following remonstrations from the management I looked around for a more appropriate and less controversial option. This loomed up in the form of a yacht. High quality boat speakers happens to be a major new US market and one that is equally attractive in Australia. The market probably has even greater potential in New Zealand, where it seems like almost every house has a boat. As I observed in Wellington recently, few of these could be classified as small boats.

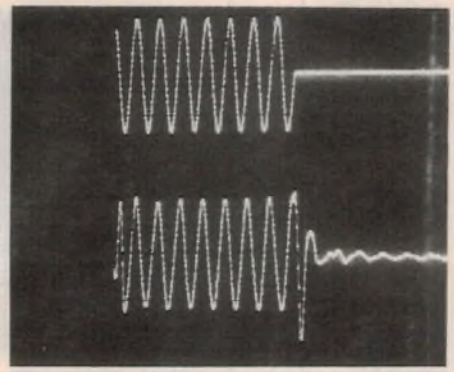
The new test bed for the CR160's was 'Pixie', a delightful new 11.5m long yacht which has been lovingly constructed and is just the sort of place where you would expect to find a good sound system. Extra special care has been applied in its construction to minimise noise, with the clear intention of providing an environment for a sound system which would be as close to the 'top of the class' as we could possibly make it.

As many of you will realise, there isn't really a lot of space in any sailing boat, and there is generally even less space available (or even suitable), for mounting loudspeakers of the calibre of the CR160's. The two spots that were selected for these built-in speakers were only fair in terms of 'domestic criteria', but these were the best that were available in terms of security of mounting and adequacy of rear space – as well as having the potential range of sound coverage that would be simultaneously achieved in both the saloon and through to the cockpit.

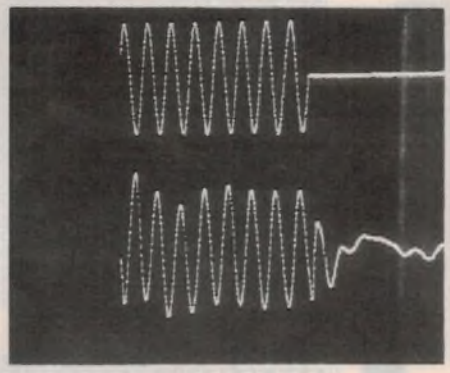
The test of installing the speakers proved to be simple, straightforward and surprisingly fast. We were ready for the subjective assessment in a couple of hours, most of which was really spent on cleaning up the saloon.

Fortunately, there was mains power available at the dock side so I decided to use a Sony CDP555 ESD CD player coupled to a Sansui B77 stereo amplifier, with inbuilt graphic equaliser and matching power output display which I felt was most desirable in these special circumstances.

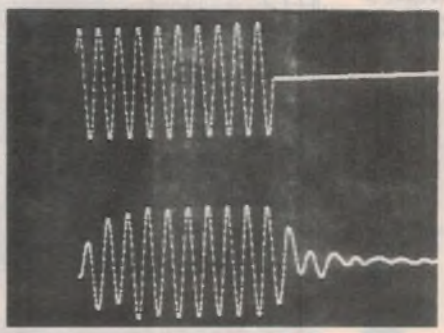
I decided to carry out some frequency response measurements in the saloon of the boat and recorded these using a Bruel & Kjaer type 4133 microphone



The tone burst response at 100Hz (upper trace input, lower trace output).



...and at 1kHz...



...and finally at 6.3kHz.

with its pre-amplifier feeding directly into a Sony PCM-2000 portable battery operated DAT recorder. The 'as installed' frequency response was measured utilising a CD test disc, which provided both swept sine waves and pink noise for that purpose. This facilitated a direct evaluation of the resonance characteristics of the mounting system, checked the adequacy of speaker's fixings and also highlighted the need for some extra stiffening of the supporting framework. Having proven that the speakers were correctly (and adequately) installed, I quickly progressed to the subjective testing.

The software I chose for my evaluation was a selection of standard test discs together with two exciting new discs which I had just received. The first disc was of the sensational Japanese new 'Wunderkind' violinist with the catchy name Midori, playing Dvorak's Concerto for Violin and Orchestra (OP53) with Zubin Mehta conducting the New York Philharmonic Orchestra (CBS MK 44923). This particular disc is one of the most brilliant renditions of what is already regarded as being a brilliant violin concerto.

Neither I nor the rest of the entourage that I had gathered for my test programme on the yacht was quite ready for the quality and brilliance of the sound that Midori and the orchestra provided. The two speakers were mounted quite low and the front face of a combined bench/berth, in the saloon of the yacht. I had initially felt sure that they would prove to be less than satisfactory in terms of sound, but I was proven to be wrong.

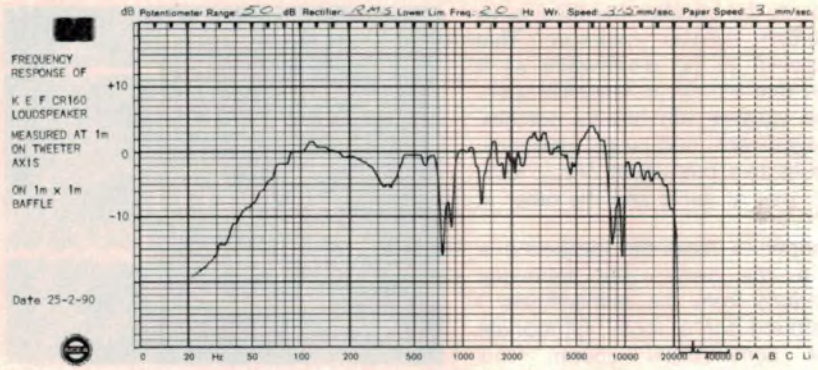
As each of us quickly discovered, you could sit on the seat with the speakers on either side of your legs, and the stereo imaging of Midori's violin was not lost. Even though the low frequency sound was being generated beside you, surprisingly there was no real loss of high frequencies. These retained most of their spatial directionality from the opposing sections of the hull and bulkhead, which you were facing. Everybody who sat on the bench voiced their satisfaction with the speakers' position, as well as with Midori's virtuosity, and each of them expressed the desire to go out and purchase this disc.

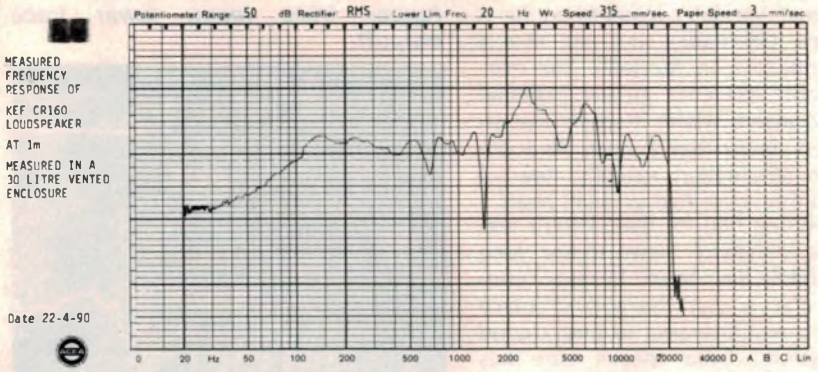
The second disc which I utilised for the subjective appraisal was a new issue of Arnold Schoenberg's 'Pelleas Und Melisande', with Daniel Barenboim conducting the Orchestre De Paris (CBS MK 38557). This is a surprisingly lyrical, equally memorable and quite outstanding disc. Schoenberg's sometimes heavy style of music is for once graceful, light and with softer presence which is somewhat atypical of much of his other music. The orchestra projected from the speakers with the full bodied sound of a 'real orchestra', and the majority of the instruments, although not as spatially well defined as in the Midori disc, readily rose to the occasion.

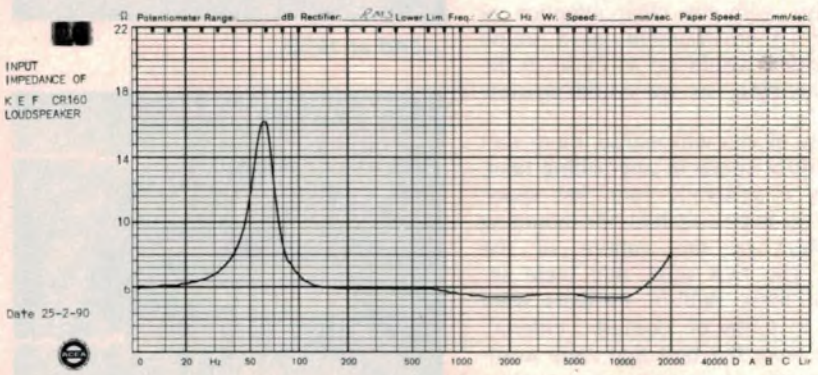
I was rewarded with a level of 'deja vu' that I was sitting in a concert hall, rather than sitting inside the small saloon of a sailing yacht. It was an exciting feeling, for these speakers were not mounted in custom built enclosures, but simply panel mounted in the vertical bulkhead of a pair of imperfectly sealed enclosures with some pillows and assorted ship's stores sharing their space.

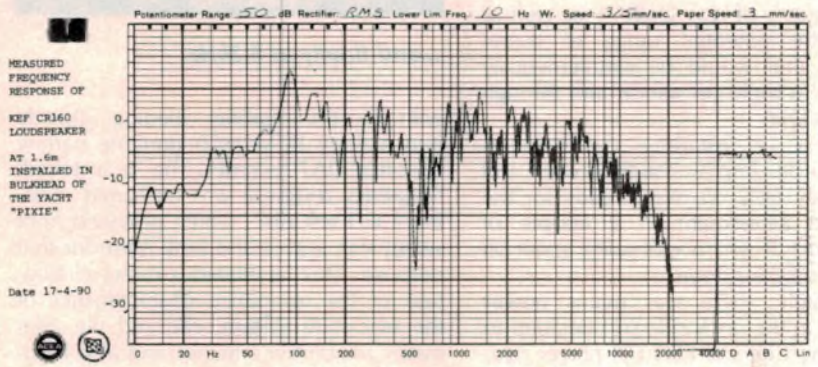
The CR160 UNI-Q speakers are a significant and positive speaker development from KEF as they produce quality

Challis on KEF's 'UNI-Q' driver...









sound from a less than satisfactory installation. They appear to be capable of providing an even better sound when they are more competently and carefully installed in either sealed enclosures or in an appropriately vented enclosure.

These speakers provide a convenient means of achieving superior sound quality in complex situations where conventional speakers 'just don't meet the bill'.

The KEF CR160 system has a recommended retail price of $599.00. Further details are available from KEF dealers, or from Australian distributors Falk Electrosound Group of 340 George Street, Waterloo 2017 or phone (02) 318 0944.

Loudspeaker Technology:

EVER ONWARD AND UPWARD...

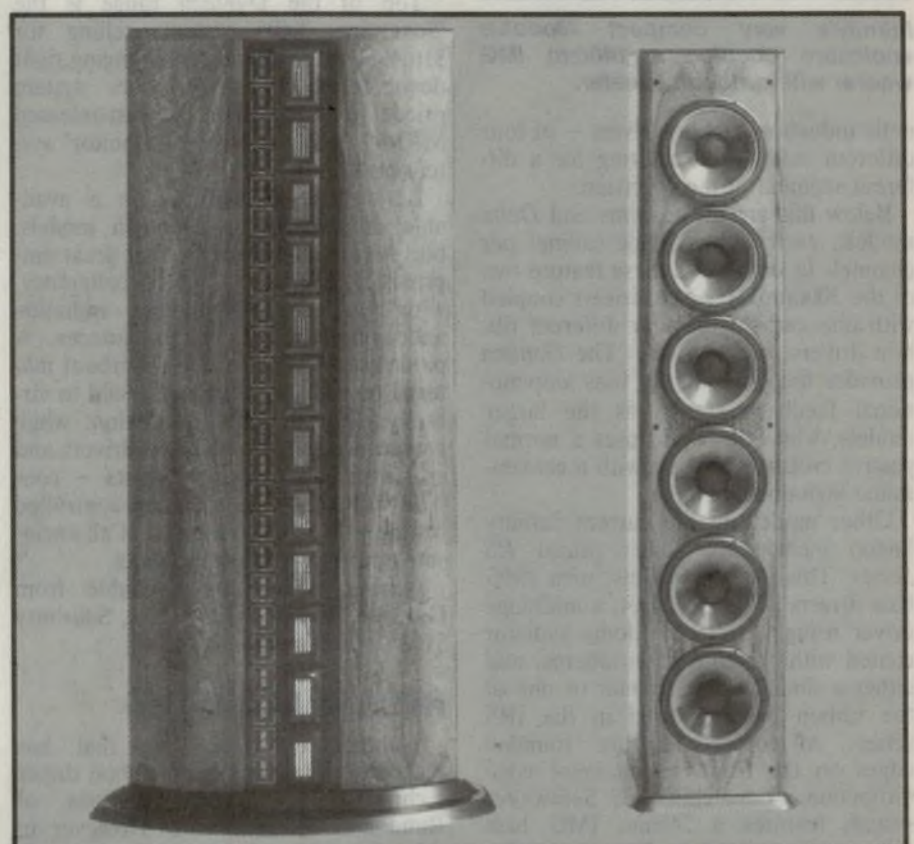
Loudspeaker technology continues to evolve and develop – spurred on as ever by the insatible urge, among designers and users alike, to approach ever more closely the ultimate goal of 'perfect' sound reproduction. However as in the past this must usually be reconciled with mundane practical considerations, such as the limited space and money available to many users – which explains the multitude of resulting design solutions. Here Jim Rowe samples the latest models and literature from many of the better-known manufacturers, to give you an idea of the current state of the art...

INFINITY SYSTEMS

Founded in the late 1960's, this California-based firm has become well known for its high quality loudspeaker systems. However in 1982 it became one of the undisputed leaders of the international industry, with the release of its top of the range *IRS* – the Infinity Reference System. As the name suggests this was intended to become 'the ultimate' performance reference, against which others would be compared. It was handmade to special order, and had a corresponding price tag: $45,000.

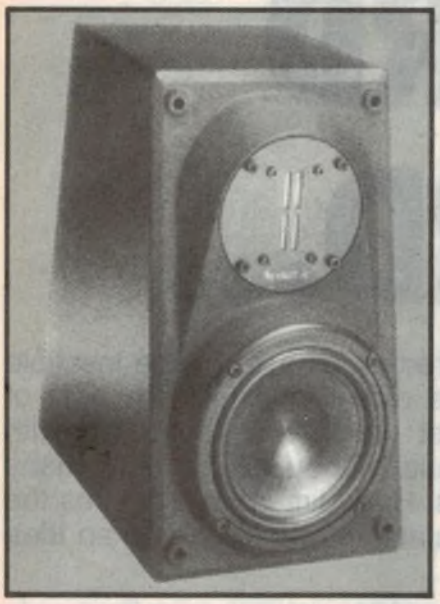
Today the IRS concept has been developed and expanded, into a complete series of IRS models. At the top of the range is the model *V*, virtually the latest update of the original model, and with a similar price. It is a four-piece system, with two 'line source' midrange/tweeter systems and two woofer modules – all of which are over 2.2m high.

The IRS *V* woofer modules each use six 300mm 'IMG' drivers, with polypropylene cones reinforced with radially aligned graphite fibres, driven by an in-built 2000W power amplifier and with a motional feedback system employing a piezoelectric 'accelerometer' to sense voice-coil motion. Equally impressive are the midrange/tweeter units, each of which uses a total of 48 ribbon-type drivers – 12 for the midrange, and 36 for the high frequencies. The ribbon drivers use Kapton diaphragms with photo-etched conductors, coupled with high-efficiency neodymium magnets. The midrange/tweeter units also feature large sand-filled 'wings' on each side of the driver panels, to reduce diffraction.



Infinity Systems' top of the line IRS V System has two of these enclosure pairs, with 48 ribbon drivers in the midrange/high enclosure (left).

The model *V* is still a 'built to order' system, but the other models in the IRS range are all normal production models. Most impressive of these is the *Beta*, again with four separate modules needing bi-amp drive. Here the bass modules each feature four of the 300mm IMG drivers, again with motional feedback, while the midrange/tweeter units each consist of five of the 'electromag-



Infinity's very compact Modulus enclosure couples a 140mm IMG woofer with a ribbon tweeter.

netic induction' ribbon drivers – of four different sizes, each catering for a different segment of the spectrum.

Below this are the *Gamma* and *Delta* models, each with a single cabinet per channel. In both cases these feature two of the 300mm IMG bass drivers coupled with one each of the four different ribbon drivers, on each side. The *Gamma* provides the same inbuilt bass amp/motional feedback system as the larger models, while the *Delta* uses a normal passive crossover for use with a conventional high-quality amp.

Other models in the current Infinity lineup include the lower priced *RS Series*. This has six models, with IMG bass drivers of various sizes, a midrange driver using a spherical dome radiator coated with graphite microspheres, and either a similar dome tweeter or one of the ribbon tweeters used in the IRS series. All models feature rounded edges on the front, to minimise edge diffraction. A matching *RS Subwoofer* system features a 245mm IMG bass driver and motional feedback via an inbuilt 100W amplifier, with variable crossover frequency.

There's also the *Modulus* system, consisting of a pair of very compact 'bookshelf' enclosures coupled with a subwoofer. Each of the smaller enclosures has a 140mm IMG polypropylene/graphite woofer, with one of Infinity's *k* ribbon tweeters; the matching subwoofer has a single 300mm IMG driver with motional feedback and an internal 250W amplifier.

Further Infinity models include the *Kappa* series, the *Studio Monitor SM* series, the *Kappa Automotive* series of drivers for mobile systems, and the *ERS* series of in-wall systems.

Further details of Infinity Systems are available from the Australian distributors, Silver Australia, of 4 Rushdale Street, Scoresby 3179 or phone (03) 763 0177.

DUNTECH AUDIO

Coming closer to home, another range of top-end loudspeaker systems that has achieved international recognition is the Duntech series made in Salisbury, South Australia. Despite being almost unknown in its home country, Duntech's flagship models have received 'rave' reviews in overseas magazines, and are top sellers in the USA, Hong Kong and West Germany.

Top of the Duntech range is the 'Sovereign 2001' system, selling for $16,495, with other models ranging right down to the 'Little Duchess' system priced at $1199, and the just-released MRM-1 'Mini Reference Monitor' system priced at only $399.

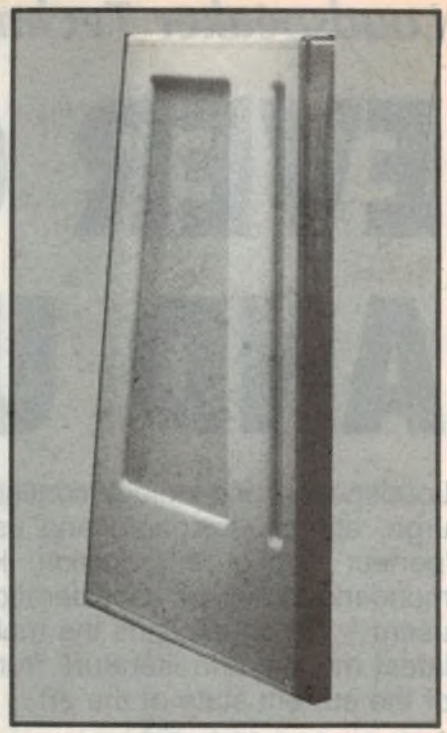
Little technical information is available on the various Duntech models, but the company stresses that great emphasis is placed on pulse coherency, with simulated point-source radiators and symmetrical radiation patterns. A patented system of using absorbent material on radiating surfaces is said to virtually eliminate edge diffraction, while computer-aided matching of drivers and crossover network components – coupled with extensive computer-controlled testing – is said to ensure that all enclosures perform well within specs.

Further details are available from Duntech Audio, PO Box 421, Salisbury 5108 or phone (08) 349 5188.

APOGEE ACOUSTICS

Another US-based firm that has placed heavy emphasis on ribbon driver technology is Apogee Acoustics, of Randolph, Massachusetts. However in this case ribbon drivers aren't used just for the midrange and high frequencies, but for the full audio range. In fact Apogee claims to be the maker of the world's first and only full-range planar ribbon loudspeaker system.

According to Apogee, the advantage of its planar ribbon systems are complete freedom from box colouration, faster transient response due to the extremely light diaphragms, and extremely low distortion. Judging by the superlatives used by reviewers to describe the performance of Apogee systems, there seems little doubt that they support the firm's claims.



Apogee Acoustics' smallest wide-range ribbon system is the Stage, which is almost a metre high.

Apogee's midrange and tweeter drivers are of reasonably conventional 'transverse' ribbon construction. A very light vertical ribbon of Kapton, carrying thin-film aluminium conductors, is suspended freely in a gap between magnet poles on each side. However the bass drivers use a different approach, with a much larger and wider ribbon carrying a 'zig-zag' conductor system, and a tensioning system which locates it accurately in front of an X-Y array of magnets, mounted on a heavy, perforated steel plate. The magnets and conductors are positioned so that the flux intercepts the horizontal ribbon conductors vertically, and in the 'up' and 'down' directions respectively for 'zig' and 'zag' conductors, so that the ribbon moves fore-and-aft as a single piston.

There are four systems in the Apogee range, with the top of the line being the *Diva* system. This consists of two three-ribbon speakers, each measuring 1855 x 788 x 75mm, and designed to operate from 100W amplifiers. They have a rated frequency response of from 'below 25Hz to over 25kHz', and can produce a sound pressure level of 118dB at 4m.

Next in line is the *Duetta Signature*

system, with a pair of two-ribbon speakers each measuring 1473 x 660 x 75mm and with a rated frequency response of below 30Hz to 20kHz.

Then there's the *Caliper Signature* system, with two-ribbon speakers each measuring 1220 x 610 x 50mm and a response from 30Hz to 20kHz. And finally the *Stage* system, with a pair of two-ribbon speakers each measuring 940 x 660 x 50mm and a rated response of 35Hz to 20kHz.

Each of the Apogee systems has a built-in passive crossover network giving 6dB/octave slope. However Apogee also provides the optional *DAX* dedicated active crossover unit, for the use with all of the systems except the *Stage*. The *DAX* has a fixed crossover frequency (330Hz) and slope (6dB/octave gradually increasing to 12dB/octave), but allows adjustment of each driver level over a 6dB range, in steps of 0.2dB – with digital readout. It also allows separate adjustment of overall 'rake angle', for greater control over balancing for room acoustics.

Further details on Apogee Acoustics systems are available from Leading Edge Audio, 49 Ramsden Street, Clifton Hill 3068 or phone (03) 489 0446.

GNP ACOUSTICS

Another respected Australian brand is GNP Acoustics, of Reservoir in Victoria, which claims to combine the best European drivers with carefully designed and hand-crafted enclosures. GNP also places great emphasis on its 'no compromise' crossover networks, which use air-cored inductors and close-tolerance polypropylene and polystyrene capacitors.

Top of the current GNP range is the *Connoisseur* system, which uses a time-aligned 6-driver four way system in each enclosure. Two 250mm Focal Edge-wound woofers are used in a push-pull reflex bass system, with the 175mm Focal midrange driver also featuring an edge-wound voicecoil. A 25mm Focal Concave Kevlar dome tweeter handles the main treble range, while the extreme highs are handled by a pair of ribbon 'super tweeters'. The rated response of the *Connoisseur* is 36Hz – 40kHz, with a sensitivity of 93dB/1W/1m and a power handling capacity of 200W RMS. Its cabinet is made from 25mm and 32mm high density craftwood, with lead lining and heavy bracing to prevent resonances.

The other member of GNP's 'Reference Series' is the *Grange* system, which has a pair of four-driver enclosures with a single 200mm long-throw woofer combined with one each of the same midrange and treble drivers used in the *Connoisseur*. It has a rated response of 38Hz – 25kHz, with a sensitivity of 91dB/1W/1m and a power handling capability of 200W.

More compact and lower priced than the Reference Series are the 'Designer Series' systems, with the largest of these being the model 100. This has a pair of 985 x 260 x 290mm enclosures, each with a two way configuration comprising 200mm Focal twin voicecoil woofer in a bass reflex system, with a 25mm dome tweeter. The rated response is 39Hz – 19kHz (+/–4dB), with power handling to 80W RMS and a sensitivity of 91dB/1W/1m.

Other models in the Designer Series are the smaller, but higher performance 'bookshelf' models 150 and 200. The 150 measures only 450 x 228 x 210mm and combines a pair of 125mm woofer/-midrange drivers with a 25mm inverted dome tweeter to give a response of 45Hz – 18.5kHz, with a sensitivity of 89dB/1W/1m and the ability to handle up to 100W RMS. The model 200 is a little larger, with enclosures 600 x 250 x 360mm housing three way configurations with a Focal Edgewound 175mm woofer, 125mm Neoflex midrange and 25mm inverted dome tweeter. It has a rated response of 40Hz – 18.5kHz, a sensitivity of 89.5dB/1W/1m and a power rating of 125W RMS.

GNP also makes available the *Ultimate* range of subwoofer systems, to augment and complement the Designer series and similar systems. There are four models in the range, ranging from the 300 SW, with two 175mm drivers

The GNP Acoustics 'Gargantuan' subwoofer system, 900mm high.

Also from GNP Acoustics is this 'Grange' four-driver widerange system.

(one per channel) and designed to serve as a coffee table, to the 'Gargantuan' model with two 400 x 400 x 900mm enclosures each containing a pair of 250mm long-throw woofers in push-pull.

Further information is available from GNP Acoustics, 2 Berwick Street, Reservoir 3073, or phone (03) 470 3171.

WHATMOUGH MONITORS

Still looking at local manufacturers, Whatmough Monitors was founded over 15 years ago and became known to aficionados for its *Mark II* system – a large (and expensive) transmission line/open baffle hybrid.

Currently the firm produces the models *201* and *201 Export*, both of which use relatively compact 540 x 285 x 310mm enclosures with optional matching stands. Each has a pair of enclosures with a two way configuration, using a 175mm dual voicecoil woofer with damped neoflex cone coupled with a 30mm Kevlar inverted dome tweeter. However the tweeter in the *201 Export* model has a larger magnet, weighing 1.4kg, and also provides front and back ventilation. In both models great attention has been paid to the crossover networks, which provide impedance compensation and feature heavy air-cored inductors and German polypropylene (*201*) or American 'audio grade' (*201 Export*) capacitors. The crossover networks are actually three way, with the two woofer voicecoils driven by the bass and mid-range signals respectively. The crossover network in the *201 Export* model is also arranged for bi-amp drive.

Both models employ cabinets made from braced particle board, internally

The Whatmough 201, another high quality locally made system. It has a 175mm neoflex cone woofer.

lined with bituminised panels to suppress resonances.

Further details on Whatmough Monitors systems are available from Leading Edge Audio, of 49 Ramsden Street, Clifton Hill 3068 or phone (03) 489 0446.

ODYL GROUP

Before we leave the local manufacturing scene, the Melbourne-based Odyl Group has just released a new wide dispersion full range system for building into ceilings or walls. Fully developed and manufactured in Australia, the Odyl *C300* system is patented; it is designed to mount flush with the surface, extending into the ceiling/wall cavity, and can be painted to match room decor.

The single driver used has a flat styrofoam diaphragm 300mm in diameter, with an overall diameter of 350mm and a depth of 65mm. With a rated frequency response of 40Hz – 18kHz (+/–4dB), with a sensitivity of 90dB and a power handling capacity of 40W RMS/80W programme.

Further details can be supplied by Odyl Group at 4/11 Molan Street, Ringwood 3134, or phone (03) 897 5111.

Above is Yamaha's AST-S1 enclosure, with the YST-SF50 enclosure below. Both are designed to take advantage of the firm's 'AST' technology.

YAMAHA

Yamaha is one of the more innovative of the audio manufacturers based in Japan, and its latest crop of loudspeaker systems reflect the company's innovative approach. They all incorporate Yamaha's new 'active servo technology' or AST principle, to achieve what seems to be outstanding performance from very compact enclosures.

Basically the AST concept seems to hinge on a special power amplifier. Unlike standard amplifiers, where the output resistance is designed to be as low as possible, the AST amplifier is designed to exhibit a *negative* output resistance, with a carefully controlled value which matches – and hence cancels out – the pure 'DC resistance' component of the speaker voicecoil impedance.

This results in extremely close coupling between the electrical drive and the voicecoil's back-EMF, giving much 'stiffer' control of the cone motion and a very high degree of electrical damping – i.e., very low effective driver 'Q'. As well as lowering distortion the usual bass resonance of the speaker cone assembly is virtually eliminated, so there is much less need for the speaker's performance to be controlled by the enclosure.

The enclosure's own resonance can be

SONANCE

Continuing the theme of 'built-in' wall and ceiling speaker systems, the pioneer in this area is Sonance, based in San Juan Capistrano, California. In fact Sonance is credited with producing the first truly 'hifi' in-wall loudspeaker system, back in 1981. Since then the popularity of so-called 'architectural audio' systems has grown dramatically, with Sonance retaining a leading position.

Currently the company produces a complete range of models, with the highest level of performance provided by the *Sonance IV*. This is a two way system combining a SEAS 210mm polypropylene cone woofer with a VIFA 25mm polycarbonate dome tweeter and 3rd-order crossover network, in an assembly measuring only 375 x 270 x 86mm – capable of being fitted in a wall with standard nominal stud depth of 100mm. The front dress frame measures 410 x 308mm, and both the frame and perforated metal grille can be painted to blend in with any decor. An alternative is to fit a cloth fabric, to match curtains etc.

Rated frequency response of the *Sonance IV* is from 35Hz to 22kHz, on the basis of it being installed in a between-studs cavity of a typical internal wall, providing around 2.5 cubic feet of volume for the 'infinite baffle' bass system. The treble response also assumes the appropriate setting for the built-in three position tweeter level switch, provided to allow compensation for absorption by the cloth or metal dress grilles.

The *Sonance IV* is rated to handle up to 100W, with a sensitivity of 90dB/1W/1m.

Other models in the Sonance range include the models *III*, *II* and *1A*, all with a cutout size of 304 x 229mm, and responses of 45Hz – 20kHz, 55Hz – 20kHz and 85Hz – 12kHz respectively. There's also the compact model *M30*, requiring a cutout of only 206 x 140mm, and the model *PSW2* subwoofer, with a 210mm dual voicecoil driver and requiring a cutout of 375 x 270mm.

Further information on all of the Sonance systems is available from the Australian distributor Concept Audio, of 32 Roger Street, Brookvale 2100 or phone (02) 938 3700.

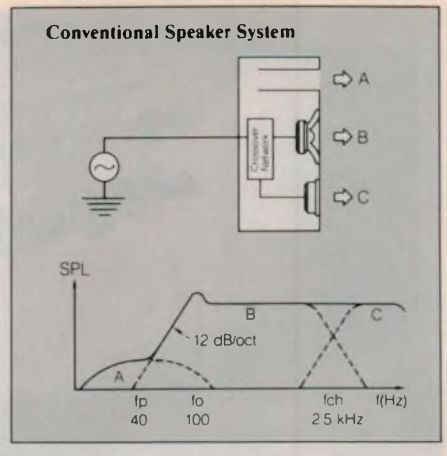
designed purely to extend the overall bass response beyond the speaker's natural rolloff, allowing a relatively small enclosure to produce surprisingly good bass response. Yamaha calls this the *air woofer* effect, as the enclosure's port seems to act as if it were an independent 'second woofer'.

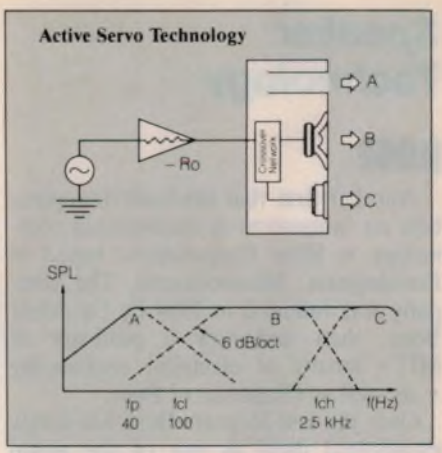
How is the AST amplifier arranged to provide a controlled negative resistance output? Yamaha hasn't released full details, but it would appear to be via a system of deriving a positive feedback component from the speaker's current.

An example of the performance which the AST principle can achieve is provided by Yamaha's new *AST-1* system. This consists of a pair of very compact enclosures – each only 297 x 230 x 188mm – driven by the matching two-channel AST-A10 'Natural Sound Active Servo Processing Amplifier'. The enclosures are two way systems, with a 160mm polypropylene cone bass/midrange driver and a 30mm soft-dome tweeter. However the rated frequency response is from 28Hz to 20kHz, with an effective loudspeaker sensitivity of 112dB/1W/1m and a power output capability equivalent to 70W RMS per channel.

The *YST-SF50* enclosures are larger but thinner, each measuring 503 x 295 x 71.5mm and fitted with four 100mm polypropylene cone bass/midrange drivers plus a single centrally placed 30mm soft-dome tweeter. But when driven by either the AST-10 amplifier or Yamaha's new *AX-630/730/930* series of integrated amplifiers with the same negative output resistance feature, the rated frequency response is a very impressive 25Hz – 30kHz, with surprisingly powerful and crisp bass response.

Yamaha has also released the *YST-SW100* subwoofer using the same AST principle. In this case the special negative resistance amplifier is built into the enclosure, making the system compatible with a wide variety of standard systems.





The subwoofer system uses a pair of 180mm drivers with 'spruce-paper' cones, and these produce an impressive response from 21Hz to 180Hz with an equivalent power output of 70W. The inbuilt amplifier has a top-cut filter with turnover adjustable over the range 40 – 140Hz and a fixed rolloff slope of 24dB/octave, to allow the system to be matched to existing system and room response.

Further information on this impressive range of new systems is available from Yamaha Music Australia at 17-33 Market Street, South Melbourne 3205 or phone (03) 699 2388.

A Sonance 'architectural audio' wide-range speaker system built into a typical internal wall. Sonance is credited with producing the first 'hifi' in-wall system, in 1981.

BOSE

Another firm that has built its reputation on innovation in loudspeaker technology is Bose Corporation, based in Framingham, Massachusetts. The company was founded in 1964 by Dr Amar Bose, then and now a professor at MIT's faculty of electrical engineering – as well as Chairman of Bose.

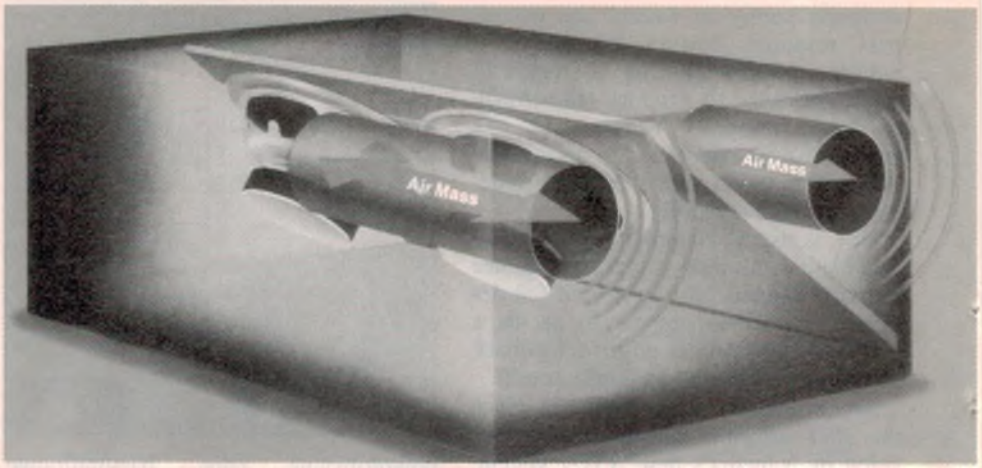
Over the last 26 years Bose has firmly established itself as one of the world leaders in professional sound systems, with wide-range and bass speaker systems that are exceptionally compact and rugged. Its professional sound systems are now very widely used in live sound reinforcement for both indoor and outdoor events, as well as for the reproduction of recorded sound in movie and live theatres, recording and film/TV studios. In fact Bose's compact wide-range enclosures with their characteristic twin-ported fronts are now quite possibly the most recognisable loudspeakers in many public buildings.

Quite early in the piece, the systems produced by Bose were distinguished by an emphasis on producing a combination of *reflected* and *direct* sound components. Bose has always maintained that this achieves greater realism than conventional systems, which generally concentrate on direct sound only, but debate about this continues.

In recent years Bose has come up with a number of further innovations, which are incorporated into its current systems. Of these perhaps the most widely known is the 'Acoustimass' principle, a development of the bass-reflex configuration.

With a normal bass-reflex enclosure the bass driver is mounted in the front panel, so that there is direct radiation from the front of its cone. Rear radiation is coupled to the air mass inside the enclosure, which is used to control and damp the speaker's natural resonance. Tuning of the enclosure is via a port, generally also brought out on the front panel, and there is radiation from this port which assists that from the front of the cone.

With the Bose Acoustimass system, the driver or drivers are mounted completely inside the enclosure, on a baffle which totally divides it into two separate compartments – each ported to the front panel. In effect, both front and rear cone surfaces are controlled separately by their own enclosure, with all



Bose's 'Acoustimass' principle uses fully enclosed drivers, with separate enclosure volumes to control front and rear cone surfaces.

sound reaching the outside via the two ports. Bose claims that this 'filtering' and damping by the twin enclosures gives higher power handling capability, lower distortion and improved efficiency.

Bose has effectively taken the Acoustimass principle further again, in its *Acoustic Wave Cannon* bass system, or 'AWCS' – effectively a subwoofer system for professional sound systems. This is in the shape of a long cylindrical tube, 3.8m long and 266mm in diameter, with a single 300mm woofer placed inside the tube at about 25% along its length. The two unequal lengths of tube coupling each cone surface to the outside form 'tuned acoustic waveguide' resonators, controlling and filtering cone movement.

Superficially one might expect this to result in two pronounced output peaks, but by careful acoustic design and the use of electrical equalisation in the drive system, Bose has been able to achieve essentially flat response from 25Hz to

The Bose 901 Series VI system, with nine 114mm drivers per enclosure – eight facing towards the rear.

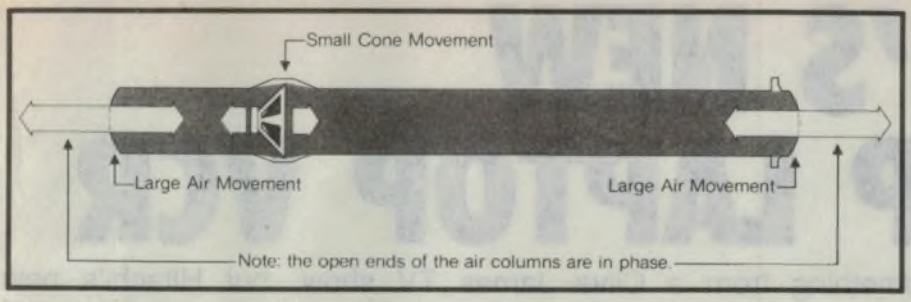
125Hz. The power handling capacity of a single AWCS is 150W RMS or 300W peak, with a sensitivity of 90dB/1W/1m. The high efficiency allows the AWCS to produce high levels of very clean bass energy.

In a sense part of the secret to Bose's success with both the Acoustimass and AWCS systems is the use of *active equalisation* – the use of tonal adjustment in the amplifier system, to compensate for the frequency characteristics of the loudspeaker system and give a balanced overall result. The same idea is apparently also used to achieve optimum results with the company's compact wide-range systems, which tend to use an array of wide-range drivers rather than the conventional woofer-midrange-tweeter lineup.

Incidentally Bose makes its all of its own drivers, which use a rugged construction and heavy duty edge-wound aluminium 'helical voicecoils' – dubbed *HVC*. From Bose's literature it's not clear exactly how these differ from normal voicecoils, which are almost always helical, or especially from those that are made from edge-wound strip conductor...

Representative examples of current domestic systems available from Bose are the *Acoustimass-5* system, which combines two tiny 187 x 117 x 92mm 'twin cube' mid/treble units with an Acoustimass subwoofer module; and the *901 Series VI* system, which consists of a pair of wide-range units each using an array of nine 114mm wide-range drivers – eight of which face towards the rear to produce the reflected sound component, and driven by a matching active equaliser unit.

Bose has also recently released a new Professional Powered Loudspeaker System, which combines an array of six



Bose's 'Acoustic Wave Cannon' bass system, an innovative 3.8m long subwoofer enclosure for professional sound systems.

114mm wide-range drivers, a 300mm woofer in an Acoustimass bass system, and a built-in 450W switch-mode amplifier – all in a package measuring only 591 x 565 x 406mm, and weighing 36.4kg.

Further information on all of the Bose systems is available from Bose Australia, 11 Muriel Avenue, Rydalmere 2116 or phone (02) 684 1255.

MONITOR AUDIO

Based at Cambridge in the UK, Monitor Audio initially made its name with loudspeaker systems using other firms' drivers. However in recent years the company has developed its own innovative drivers, including a gold-anodised metal dome tweeter.

Now MA's designer/founder Mo Iqbal has launched a new range of metal coned bass/midrange drivers. These are made using a three-stage process, where the metal is drawn to a final thickness of only 100um (0.1mm), and then electrically coated on each side with 50um layers of ceramic material. This is described as providing damping to the cone – plus stiffening, as the first cone breakup mode doesn't occur until over 6kHz. A hard, synthetic phase-correcting plug is mounted in the centre of the cone, while the inverted roll surround is made from high compliance nitrile rubber.

MA's new *Studio 10* system partners one of the new drivers (a 170mm model) with its existing metal dome tweeter, in a compact 400 x 250 x 200mm bass-reflex enclosure. The quoted response is 40Hz – 20kHz, a sensitivity of 88.5dB/1W/1m and an power handling capability of 200W.

Further information on Monitor Audio's drivers and systems is available from the Australian distributors Audio 2000, at 137 Victoria Road, Drummoyne 2047, or phone (02) 819 6533.

SUMMARY

I hope this sampling from the latest model loudspeaker systems and drivers has given you at least an idea of the current state of development in loudspeaker technology. Audio technology as a whole is not an easy area to summarise, because of its inherent conflict between objective and subjective considerations.

In particular the objective aspects of developments in speaker technology can be exceptionally difficult to grasp and understand, due to the enveloping 'smog' of marketing hyperbole. There *are* significant developments, as you can hopefully see from the above, although these are probably best described as 'evolutionary' rather than 'revolutionary' – despite the understandable enthusiasm of marketing and sales people.

HITACHI'S NEW FLIP-TOP LAPTOP VCR

Yes, it sounds a little like something from a Clive James TV show, but Hitachi's new VT-LC50EM really is a flip-top, laptop, all colour, multistandard, self contained, pick it up and carry it along VHS video recorder and TV receiver combination. About the only thing that's lacking is the satellite dish and downconverter!

by LES CARDILINI

Released in Australia during May this year, Hitachi's new laptop VCR model VT-LC50EM is possibly the first portable VHS VCR to reach us with its own built-in picture and sound.

The VT-LC50EM weighs only 3.4 kilograms and is not much bigger than a attache case or handbag, but it handles full-size VHS videocassettes.

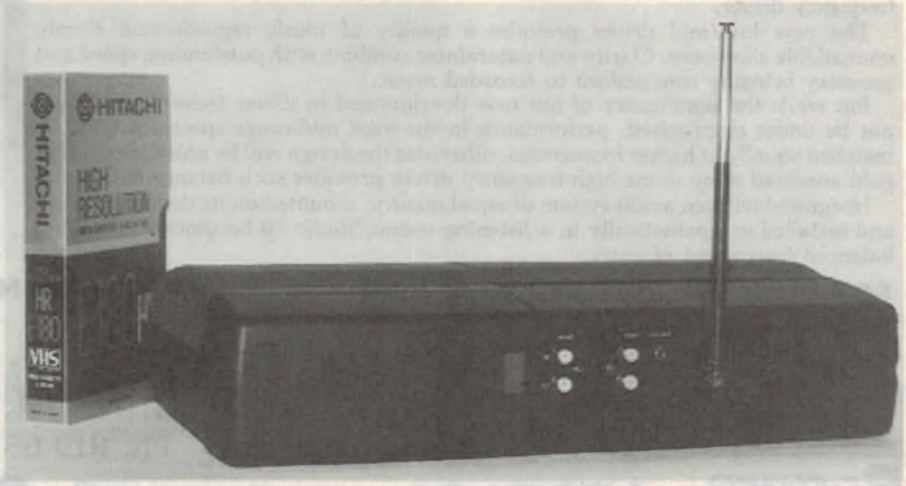
The laptop follows hot on the heels of Hitachi's innovative automatic head cleaning model, and is perhaps better described as a video deck: a compact AC-DC portable multi-system VHS VCR and TV receiver combination complete with telescopic TV antenna, loudspeaker sound and a retracting carry handle for total mobility.

The set has some obvious attractions as a personal AC-DC portable VHS VCR-cum-TV set for, say, hospital patients or for domestic or business use. But the VT-LC50EM has a number of additional features that should appeal to both travellers and anyone who requires to play video recordings made in countries with different TV standards from our own PAL system.

This new Hitachi video deck automatically handles videocassettes recorded in the various video formats used around the world, including PAL, SECAM and the NTSC system which serves Japan, Canada and the United States of America.

Having video recordings 'translated' from one video format to another can as a rule be a relatively expensive exercise, especially if it is necessary to do so on frequent occasions. A multi-system VCR at the ready helps to avoid the inconvenience and expense of having tapes translated for viewing, particularly in out-of-the-way places and at very short notice. Business agents and consultants, for example, might find a machine like the VT-LC50EM to be a very handy addition to the communications resources kit.

The VT-LC50EM laptop VCR can also be used to watch and (where copyright laws permit) record local television, while on holiday or business trips overseas. The set's inbuilt TV tuner can be switched to receive PAL and SECAM TV broadcasts in Europe, China and the USSR, The Middle East,



Top and above: two views of Hitachi's compact new VT-LC50EM portable VHS recorder/TV receiver combination.

Asia and Australia.

(The VCR will play back tapes recorded in the NTSC system used in Japan, Canada and the US, but it is not designed to receive the regular TV programs broadcast in the NTSC standard, off-air. However, NTSC recordings can be made using the VT-LC50EM by connecting a suitable cable between the Video Out socket on an NTSC monitor-style TV set or an NTSC VCR, and the video input socket on the VT-LC50EM. For practical purposes it should be as easy as interconnecting two PAL VCRs at home.)

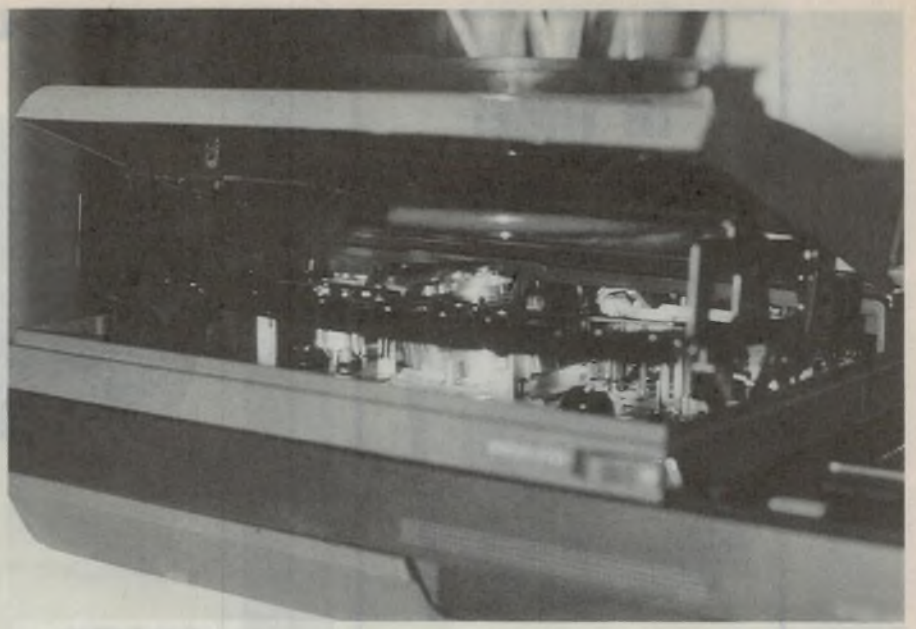
Potential problems with different AC mains voltages and frequencies in other countries are also minimised with the VT-LC50EM, which may be operated on its rechargeable NiCad battery pack or from the AC mains using the power universal AC mains adaptor-charger that comes with the unit.

The AC adaptor supplied with the VT-LC50EM automatically adjusts to the AC mains voltage and frequency. This helps to avoid those nasty and often expensive little accidents that might occur due to lapses in concentration – when, for example, jet-lagged travellers plug mains operated appliances into unfamiliar mains sockets. A DC power lead is also included for connecting an external 9.6 volt battery or DC power source.

The rechargeable NiCad battery supplied with the VT-LC50EM has a capacity of 2000 milliampere-hours (mA.h), and clips securely in place on the back corner of the video deck to power the set on DC. It also lowers the centre of gravity for added equilibrium when the VT-LC50EM is placed down, briefcase style while it is on field duty, as a portable. A moulded battery cover keeps the battery out of sight and maintains the cabinet's lines and general appearance.

To operate the VT-LC50EM from the AC mains the AC adaptor-charger supplied with the set is plugged into the mains and connects to the deck via a DC lead plugged into the 9.6V external DC socket. Adjustment to the applied AC mains voltage is automatic within the range 100-240 volts and for either 50Hz or 60Hz mains frequency. The NiCad battery is recharged by removing it from the video deck and simply clipping it to the side of the adaptor-charger, before switching on the mains.

A smaller, 3 volt lithium battery (CR-2025 or equivalent) is used as a backup for the internal time-of-day clock and TV channel tuning memory when the set is otherwise switched off. This should hold the correct time and preset channel memory for approximately one year, according to specifications provided with the set.



A closeup look with the transport lid raised, with the head drum partly visible in the centre. It takes full-size VHS cassettes.

When the lid is opened on the VT-LC50EM, up pops the slim 127mm (5") full colour LCD (liquid crystal display) picture. At the same time the accompanying sound from the TV or videotapes can be heard through the set's own amplifier and loudspeaker, or headphones if preferred. For larger-screen viewing the VT-LC50EM may be connected to a regular TV set or monitor system, like a 'conventional' VCR.

The LCD screen is switched off automatically to save the battery, when the display lid is closed over the operator panel. This includes the regular VCR controls and TV tuning plus display functions.

Sleep and wake-up timers and programmed recording are also featured in the VT-LC50EM, and the time of day can be called up promptly in the display and superimposed briefly on the picture, if required. The on-screen display can also be switched to show other information such as the TV system mode selected, playing times and VCR status and which channel is currently selected from the memory TV tuning.

Up to 20 preset channels in the various PAL and SECAM VHF and UHF TV systems can be stored in the set's TV tuning memory, and depending on the quality of TV reception in a particular area the VT-LC50EM laptop VCR may be operated on its own telescopic rod antenna or, alternatively, from an external antenna using a two-way splitter accessory supplied with the set and the conventional coaxial RF IN, or antenna socket on the back of the VT-LC50EM.

Long play and standard play VCR speeds provide videocassette playing times up to 480 minutes (PAL long play mode.)

Audio and video input and output connectors, also mounted on the rear panel, can be used for dubbing or recording with other VCRs and for recording and playing back tapes with monitor style systems. These are selected via the Line-Tuner switch button on the main control panel.

Two earphone sockets are also provided, for personal listening to TV or video sound. Using one earphone socket disconnects the internal loudspeaker in the video deck. The other earphone socket does not interfere with speaker operation. The set has its own volume control.

Picture clarity provided by the 114,240 picture elements (pixels) in the liquid crystal display on the VT-LC50EM is enhanced by fluorescent back-lighting, which enables the screen to be used in bright and subdued ambient lighting and the dark. This contrasts with the limitations of LCD displays in watches and calculator displays, for example, which have reflective panels behind their displays and depend on relatively high levels of ambient light for brightness and clarity.

Besides being much flatter and lighter in weight than conventional TV picture

Hitachi's Laptop VCR

Two further views of the VCR, showing the right-hand end (above) and the screen/control panel. The 5″ LCD has built-in backlighting.

in weight than conventional TV picture tubes, LCDs of course require significantly less power and are therefore more ideally suited for use in battery operated video systems with small picture screens.

Picture brightness and contrast provided by the LCD panel on the model reviewed was more than adequate for viewing in normal ambient light.

Natural colour was adjustable through a wide range of saturation levels. The indexed brightness and colour controls, together with a tint control for NTSC color reception, are recessed into the side of the lid housing the LCD screen.

The lid may also be tilted backward or forward, to avoid unwanted reflections in the screen and affords a wide range of viewing angles, such as might be required between placing the video deck in the viewer's lap or on a table or desk.

A 14-page instruction manual printed in English clearly identifies features on the VT-LC50EM and describes how to adjust functions such as the timers, preset tuning and automatic programming. Details for multi-system operation are also provided in the hand manual.

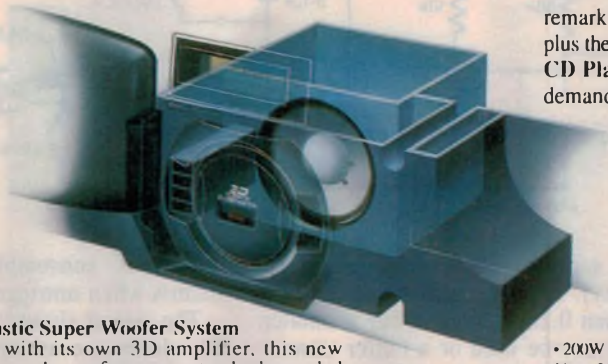
Measuring just 370 x 89 x 215 (w x h x d) millimetres, the Hitachi laptop multi-system VHS VCR and 12.7cm (5″) LCD colour television model VT-LC50EM is in the hand luggage class – you will find bigger radio-cassette recorders.

Recommended retail price for the VT-LC50EM, including accessories, is $3499, or $2300 duty-free to approved buyers. The set is covered by a 12-month warranty.

Further information may be obtained from Hitachi Sales Australia, 153 Keys Road, Moorabbin, Victoria 3189 or phone (03) 555 8722.

The New 1990 Model

Hitachi breaks the sound barrier- Acoustic Super Woofer in a portable unit.



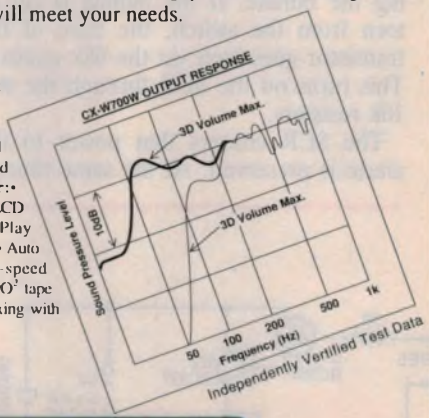
New Acoustic Super Woofer System
Equipped with its own 3D amplifier, this new system meets the performance standards needed for high-quality digital sound. And by sealing the super woofer in a rear chamber, reverse phase frequencies are prevented from interfering with low-frequency output ensuring clear, rich bass.

Hitachi CX-W700W offers sound quality equal to that of many mini-component systems in a portable unit. You get a remarkable 200W (PMPO) audio output with powerful, solid bass, plus the full benefit of CD digital sound.

CD Player: The optimum quality of digitally recorded sound demands a high level of performance from the amplifier and speakers. Hitachi CX-W700W delivers the wide frequency response needed to get the most out of CD recordings.

Home Music System: Hitachi CX-W700W is equipped with radio, twin cassette decks and a CD player. So whatever your choice in listening pleasure, this single compact unit will meet your needs.

• 200W (PMPO) audio output • New 3D Acoustic Super Woofer system • Two full-range12cm speakers • Surround sound system • Three-band graphic equalizer **CD Player:**• 32- program random memory • LCD track number display • CD Play /Rec.Synchro **Cassette Decks:** • Auto Reverse (on Tape 1) • High-speed dubbing • AutoStop & Nor/CrO^2 tape selector (on Tape 2) • Mic mixing with volume control.



3D BASS ACOUSTIC SUPER WOOFER

COMPACT disc DIGITAL AUDIO

CX-W700W

Portable 4 Band Radio/Stereo Double CassetteRecorder/ CD Player with 3D Super Woofer

HITACHI

Victoria: (03) 5558722 New South Wales (02) 6663088 Queensland: (07) 260 1344 South Australia: (08) 347 1234 Western Australia: (09) 277 9955 Tasmania: (002) 72 5651

Addam Design 4491

READER INFO No. 28

Circuit & Design Ideas

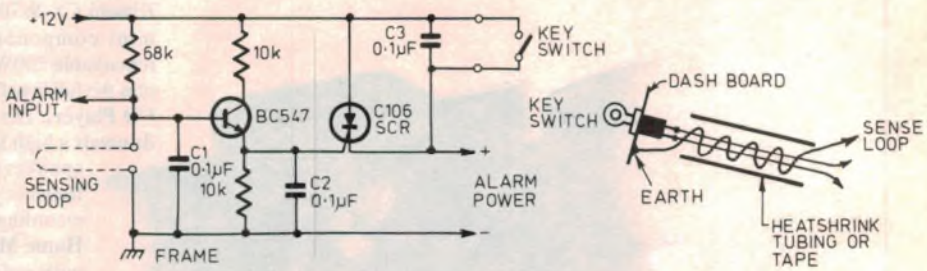
Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

Car alarm protector

While installing an alarm in a friend's car, I realised that it could effectively be disabled by merely cutting the wires to the keyswitch on the dash. The attached circuit was devised to prevent this occurring.

The base of the BC547 is held low by a sense loop that is wrapped around the keyswitch wires (as shown) before taping the bundle. If the bundle is cut or torn from the switch, the base of the transistor goes high via the 68k resistor. This turns on the SCR through the two 10k resistors.

The SCR ensures that power to the alarm is preserved. At the same time, a high is sent to retrigger the alarm (if necessary). If your alarm inputs require more than 0.2mA, then either a smaller resistor may be used or a buffer transistor. C1 protects the circuit from ignition spikes, while C2 and C3 protect the SCR from switch pulses.

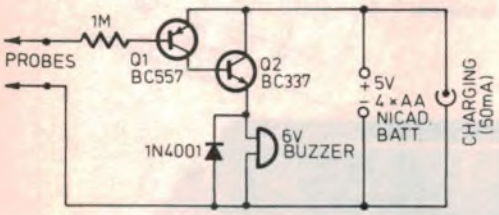


Current consumption is less than 0.2mA when untriggered.

The circuit should be mounted within the alarm case, except of course, for the sensing loop.

Leon Miguel,
Hope Valley, WA.

$35



Water level alarm

With this gadget there is no more overflowing tubs and sinks. When the water reaches the probes, Q1 gets base current via the 1M resistor and the earth path and conducts. This then allows current to flow from the positive rail to the base of Q2, and turns on the 6V buzzer (an L7009 from DSE was used here). The diode protects the circuitry from EMF produced in electromagnetic buzzers.

In my case, the gadget is powered by 4 x AA Nicads, and is quite loud enough. The components fit neatly into a UB-5 case with the buzzer on top.

The probes are heavy insulated wire, poking through the case and bent into whatever shape is required to hang onto a tub, sink, etc. The circuit needs no switch and one charge ought to provide over a thousand warnings.

Rolf Sommerhalder,
Rylston, NSW

$35

Novel 'decision maker'

A while ago I was asked to make a decision maker, for a boss who was leaving. So I came up with this novel circuit. Although it is a simple circuit, it has two extra features:

1. The 'too hard' LED flashes.
2. It has auto power ON/OFF.

When SW1 is pressed, C1 charges up via the diode and IC1a pin 3 goes low. The transistor turns on and supplies power to IC2. At the same time SW1 enables oscillator IC1b, which clocks IC2 at high speed. When SW1 is released IC1b is disabled and one of IC2's outputs remains high turning on one of the LEDs.

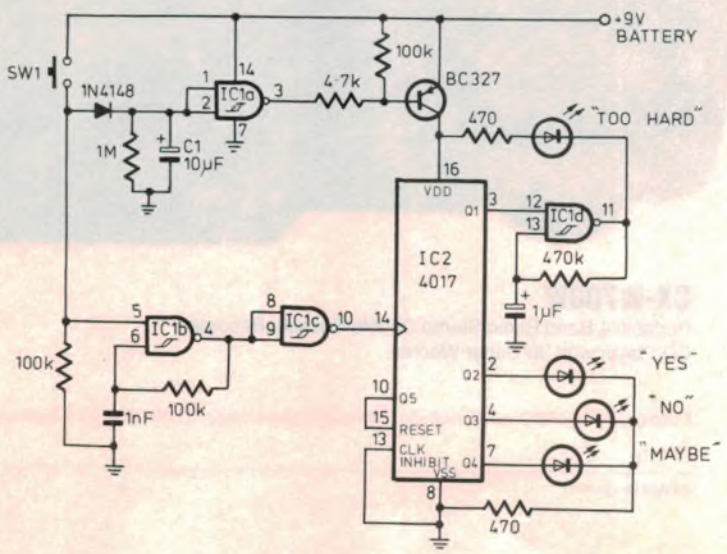
If pin 3 remains high oscillator IC1d is enabled and the 'too hard' LED flashes at about 2Hz. Otherwise one of the other LEDs will operate.

About 10 seconds after SW1 is released, C1 discharges via the 1M resistor. Pin 3 of IC1a returns high and turns off the transistor, removing power from IC2.

IC1c is used to invert the high from pin 4 of IC1b and present a low to pin 14 of IC2 so that when power is removed from IC2, its input does not exceed its supply voltage.

Lindsay Kafer,
Leichhardt, Qld.

$40



If you've developed an interesting circuit or design idea, like those published, why not send us the details? As you can see, we pay for those we publish – not a fortune, but surely enough to pay for the effort of drawing out your circuit, jotting down some notes and sending the lot, together with your name and address to Jim Rowe, Electronics Australia, PO Box 227, Waterloo 2017.

Seedling heater thermostat

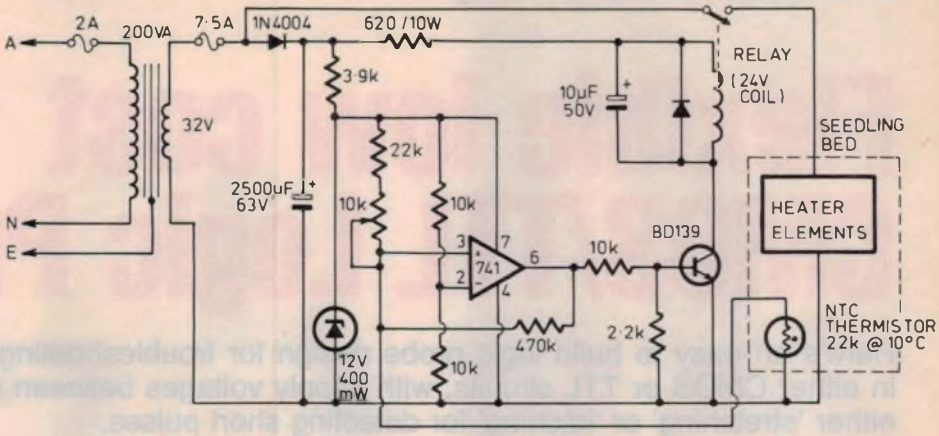
This electronic thermostat circuit was produced to allow seedlings to be grown in the cooler winter months, here in the mountains.

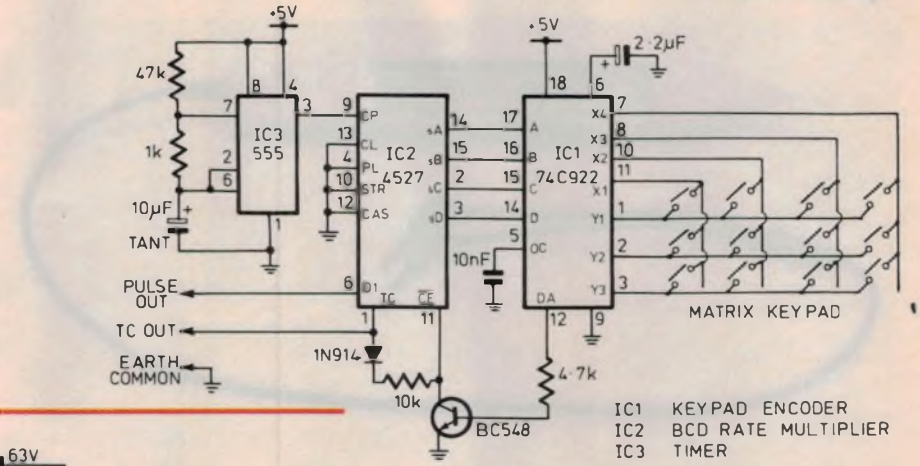
The circuit is fairly straightforward, the 32V transformer being used as a safety precaution in the wet environment of a hothouse. The heating elements are made from old electric blankets, but any kind of element would be OK as long as suitable power can be supplied by the transformer.

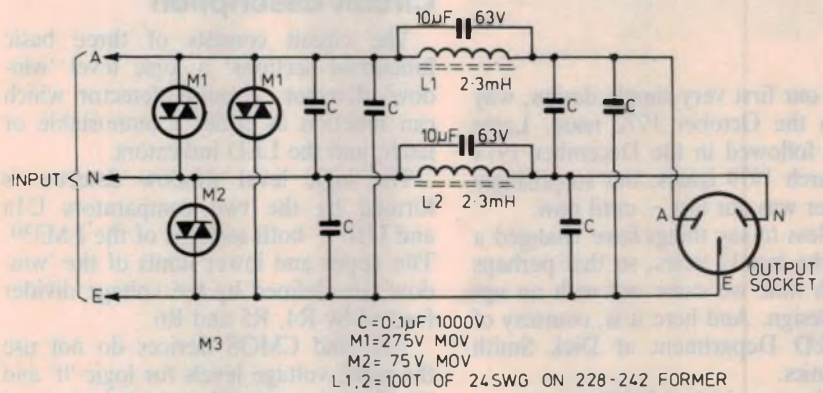
Temperature control is by the NTC thermistor, with adjustment of the switch-on temperature via the 10k pot. The 470k resistor between pins 6 and 3 of the 741 give a hysteresis of approximately 1.9°C, which is narrow enough for growing seedlings in winter.

M.R. O'Neill,
Blackheath, NSW

$45







Tuned mains filter

Here is a mains filter circuit that I developed to ensure reliable operation of my firm's computers. There are many such circuits, but in our area the 1050Hz tones used to control hot water systems proved to be a problem, and we needed to achieve better rejection of this frequency.

The inductors each consist of 100 turns of 24SWG enamelled copper wire, wound on a Radiospares 228-242 former (6 layers, full bobbin). They have a Q of around 40 and an inductance of close to 2.3mH, so that if the shunt capacitors are close to their nominal value of 10uF, they will resonate at 1050Hz.

All capacitors marked C are 0.1uF/1000V types, and should ideally be of the self-healing dielectric type for AC mains operation. MOV varistors M1 should be rated at 275V, while M2 should be rated at 75V. Needless to say the entire circuit should be housed in either a fully insulated box, or preferably an earthed metal case to prevent radiation from the inductors.

Paul Spresser,
Morningside, Qld.

$30

Serial keypad encoder

For one of my projects, I required a simple keypad which had to be small and compact with a serial output. This one works well!

A keypress produces a binary output on IC1, which in turn sets the inputs on IC2, dictating the number of pulses to be produced at the output of IC2.

At the same time, a pulse is produced at the 'data available' output, pin 12 of IC1. This turns the transistor on, grounding CE-bar on IC2.

Tc then goes low, keeping CE-bar low, even when the transistor is turned off. The pulses then appear on the output (pin 6) of IC2.

Tc returns to a high state at the end of the pulse cycle, disenabling IC2, which is reset and ready for another keypress.

IC3 dictates the speed of the pulses. All unused inputs on IC2 are grounded.

I have found this project to be useful also, as a piece of test gear, when a set number of pulses are required.

David Kadow,
Plympton, SA

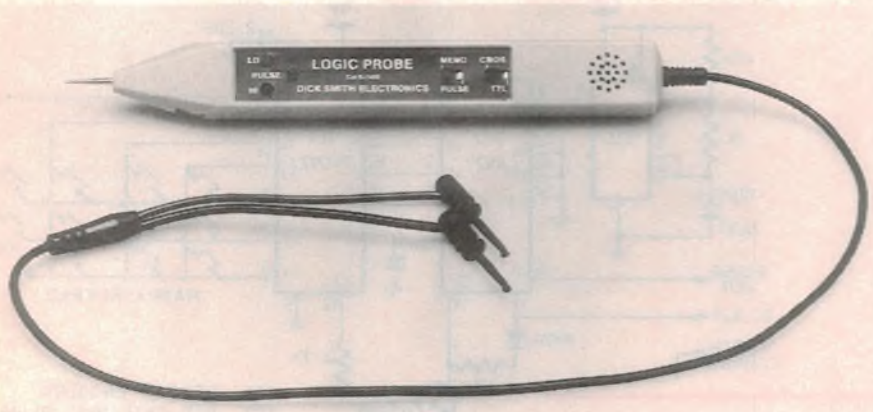
$40

Construction Project:

Flexible low cost CMOS/TTL Logic Probe

Here's an easy to build logic probe design for troubleshooting in digital circuitry. It will operate in either CMOS or TTL circuits, with supply voltages between 5V and 15V, and has a choice of either 'stretching' or 'latching' for detecting short pulses.

by JIM ROWE



A logic probe is very handy when you're trying to track down faults in digital systems. With level indicators right near the probe tip, it allows you to check critical logic levels much faster than with more sophisticated instruments like a logic analyser, oscilloscope or DMM – and without getting sore neck muscles!

The other main advantage of logic probes is that they're relatively low in cost. This even applies to many commercially marketed models, although some are still pitched at a price level that makes them rather more attractive to companies than to private individuals...

Of course the way to get a logic probe for the best possible price is to build it yourself, as with many other test instruments. This also has the advantage that having built it, you're generally able to be more confident in its operation – or at least, you're better able to fix it, if a fault should develop.

Over the years *Electronics Australia* has described a number of logic probe designs. As it happens I myself described our first very simple design, way back in the October 1972 issue. Later designs followed in the December 1974 and March 1979 issues, but surprisingly the latter was our last – until now.

Needless to say things *have* changed a tad in the last 11 years, so that perhaps it's high time we came out with an updated design. And here it is, courtesy of the R&D Department at Dick Smith Electronics.

Based on a single LM339 low power quad comparator IC, the new design gives reliable indication of logic 'high' and 'low' levels in both TTL circuitry operating from the usual 5V supply, and CMOS circuitry operating from supplies anywhere between 5V and 15V. It also has a stretching/latch circuit which can either stretch narrow pulses to make them more visible, or use them to trigger a latch for more reliable indication.

All of the circuitry for the new probe mounts on a compact PC board, which fits inside a neat little moulded probe case. The whole thing goes together very easily, to produce a sturdy and practical testing tool – at a cost low enough to allow making one for the service kit, as well as for the home workshop bench.

As noted, the design for the probe comes from Dick Smith Electronics. This means that the PCB pattern and LED/switch panel designs are proprietary, and can't be supplied by other firms. Individual readers are of course free to make their own if they wish, but in any case DSE is marketing a complete kit for the project, with the designation K-7405 and priced at only $24.95.

Circuit description

The circuit consists of three basic functional sections: a logic level 'window' detector, a pulse detector which can function as either a monostable or latch, and the LED indicators.

The logic level window detector is formed by the two comparators U1a and U1b – both sections of the LM339. The upper and lower limits of the 'window' are defined by the voltage divider formed by R4, R5 and R6.

TTL and CMOS devices do not use the same voltage levels for logic '0' and '1'; the minimum '1' or high logic level in particular is different, as a proportion of the supply voltage (see Table 1). As a result, it is necessary to adjust the window thresholds for the two kinds of logic family. This is performed by the CMOS/TTL switch SW1.

In CMOS mode, R7 is paralleled with R6 to make the upper window threshold 2/3rds of the supply rail. On the other hand in TTL mode, R6 alone sets the upper window threshold at slightly less than 1/2 the voltage rail – in this case 5V.

Note that CMOS is run from supply rails normally between +5 and +15 volts, and its high and low logic levels

are relative to its supply rail. TTL in contrast is always run from +5 volts, and its Hi and Lo levels are always the same. Needless to say, to ensure correct operation of the logic probe it is necessary to operate it from the same power supply rails used to run the circuitry being tested.

When the input to the logic probe is floating, its input probe is held at a level between the limits of the detection window, by the voltage divider formed by R1 and R2. This voltage is coupled via series protection resistor R3 to the '–' input of U1a and the '+' input of U1b. Hence in this condition, or if the probe tip is connected to a voltage between the maximum Lo and the minimum Hi levels, the input voltage will be inside the window determined by the reference voltage divider (R4, R5 and R6 or R6//R7). In this case neither comparator will turn on, and so the outputs of both will be held high by R8 and R10.

Note that the LM339 comparators have open-collector type outputs, which can only pull low. They only do this when the voltage at the '+' input becomes *negative* with respect to that at the '–' input.

If the probe tip is connected to a voltage which is higher or lower than the window limits, the output of one of the comparators will become low, and one or other of LED1 or LED2 will illuminate. This, then, is how the probe indicates steady logic levels; now let us consider pulses.

Let's assume that the probe input consists of a positive-going pulse, which starts at 0, goes to 1 briefly, and returns to 0. The initial low level turns U1b on, so its output is low; meanwhile U1a is off so its output is pulled high by R8. Therefore C4 is charged via R11, while C3 remains discharged.

At the pulse transition to 1, the output of U1a goes low, while that of U1b goes high. The positive-going edge from U1b adds to the charge across C4, and D4 conducts – passing a positive-going pulse to pin 4 of U1c. The pulse lasts until C4 is discharged, through D4 and D5 and finally by R11.

When the original input pulse returns to 0, a similar process *may* take place – providing the pulse duration has been long enough for C3 to have charged via R9. This requires about 1 millisecond. For pulses of around this duration or longer, the end of the pulse will cause C3 to pass a second positive-going pulse to U1c via D3.

Input pulses of approximately 1ms duration or longer will therefore cause two short pulses to be fed to U1c, while those much shorter than 1ms will only produce one pulse.

The main idea of having the two R-C circuits and diodes is not to produce two pulses from each input pulse, though. It's really to allow the circuit to respond to negative-going pulses, as well as those that are positive-going.

Operation with a negative-going pulse superimposed on a steady 'Hi' level is very similar to the sequence just described for a positive-going pulse. The only difference is that U1a is initially 'on', with C3 charged, and U1b 'off' with C4 discharged. On the arrival of the pulse U1a will turn off, feeding a pulse to U1c via D3, while at the end of the pulse U1b will turn off and (if the pulse has been long enough for C4 to charge) feed a second pulse via D4.

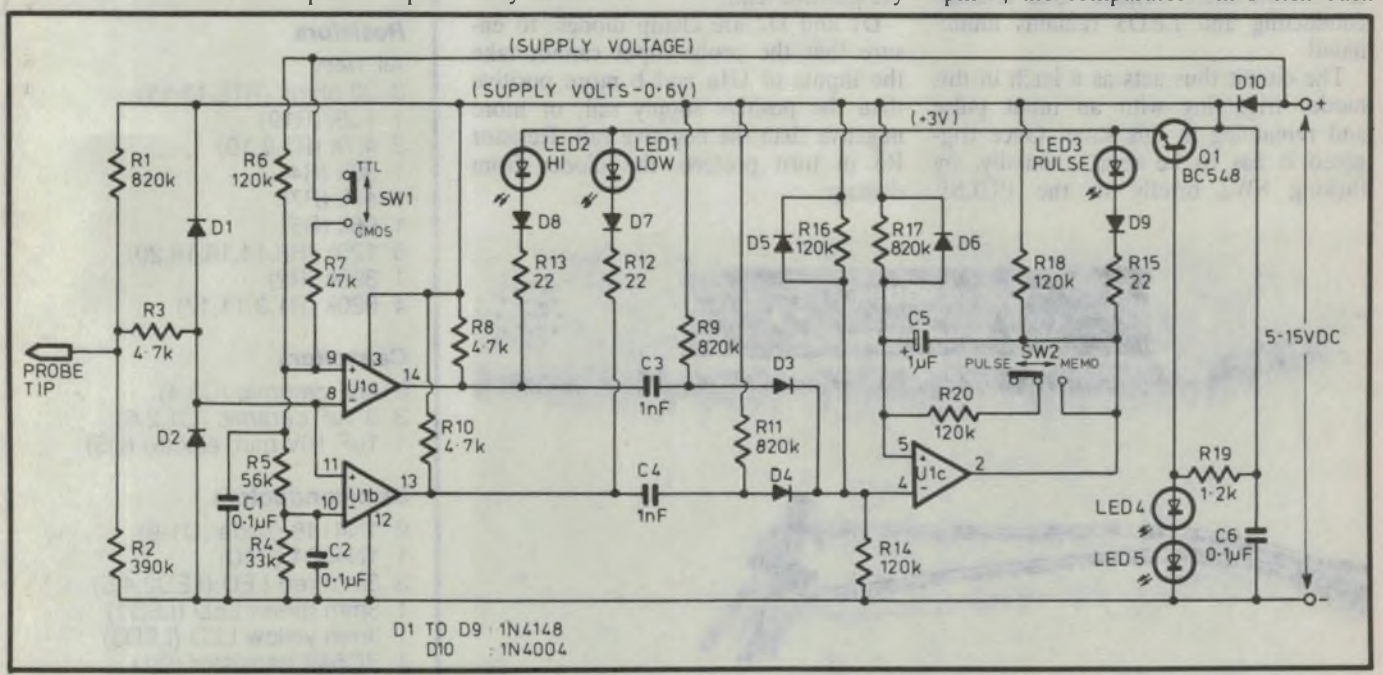
So the combined effect of the circuitry around C3, C4, D3 and D4 is to feed either one or two positive-going pulses to U1c, regardless of whether the input pulses are positive- or negative-going. The fact that two pulses are produced when the input pulses are longer than about 1ms is something of a bonus.

The voltage divider formed by R16 and R14 keeps pin 4 of U1c normally at half the supply voltage. On the other hand pin 5 is normally held near the positive rail voltage, by R17.

During the positive-going pulses fed via D3 and D4, pin 4 of U1c is briefly taken to a level above that on pin 5. The level reached is clamped by D5, but it is positive enough to make the comparator switch – causing its output go low. And when it goes low, the negative end of C5 is pulled low with it, causing C5 to commence charging via R17.

The charging current of C5 pulls the pin 5 of U1c down below the level of the R14/R16 divider, ensuring that the comparator stays in its switched state after the incoming pulse has ended.

C5 charges relatively slowly via R17, due to the relatively long R-C time constant. Once the current falls and the voltage at pin 5 rises above the level at pin 4, the comparator will switch back



The circuit schematic for the probe. It will operate reliably in either TTL or CMOS circuitry, while the novel circuitry associated with U1c will either stretch or latch on pulses of either polarity.

TABLE 1:
CMOS & TTL LOGIC LEVELS

Family	Maximum level for logic low	Minimum level for logic Hi
CMOS	26.7% of Vcc	73.3% of Vcc
TTL	0.8V	2.0V

to its 'off' state, with its output high again.

As LED3 is also connected to the output of U1c, it illuminates during the period that the comparator is switched on. So the nett result of all this is that U1c acts as a monostable, which effectively 'stretches' the length of the input pulse to make it visible via LED3.

The foregoing explanation assumed that the Pulse/Memo switch SW2 was open, corresponding to the probe's 'PULSE' mode. The operation changes when SW2 is closed, to set it for MEMO (memory) operation.

When SW2 is closed, this does not effect operation before the arrival of an input pulse, as the output of U1c is non-conducting and pin 2 is pulled high by R18. However once a pulse arrives and U1c is triggered into conduction, its output voltage falls and R20 holds pin 5 down to a level below the quiescent level on pin 4 set by R16 and R14. Hence even when C5 has charged to this intermediate voltage, U1c remains conducting and LED3 remains illuminated.

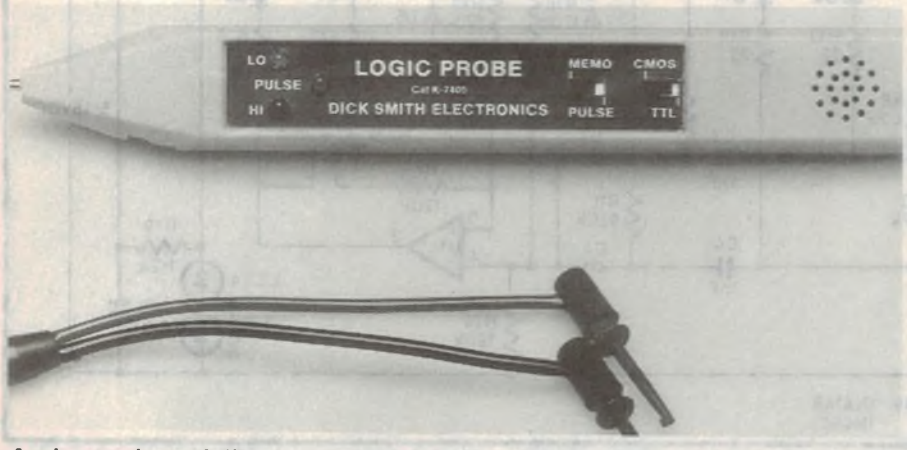
The circuit thus acts as a latch in this mode, triggering with an input pulse and remaining in this state. Once triggered it has to be reset manually, by flicking SW2 briefly to the PULSE mode; this allows C5 to continue charging as before, and finally the voltage at pin 5 rises above that of pin 4 so that U1c can switch off.

If you've been wondering about the function of Q1 and its associated circuitry, this is basically a voltage regulator circuit to supply the indicator LEDs with a constant 3V DC, so that their brightness is substantially constant despite the probe being powered from supplies of anywhere between 5V and 15V.

Q1 is a standard emitter follower, while LED4 and LED5 are being used here as voltage reference diodes, supplied from the main positive rail via R19. The reason for using two series-connected LEDs instead of a 3.6V zener diode is that this gives rather better regulation, at the relatively low current used here. Typical 3.6V zeners have a somewhat higher dynamic resistance, and the resulting poorer regulation causes the LEDs to be quite dim with a 5V supply, and over-bright with a 15V supply.

Diode D10 is to protect the probe circuitry against reverse polarity connection of the supply leads. However as D10 has a voltage drop of around 0.6V, the top of the input reference voltage divider R4/R5/R6-7 is connected directly to the incoming positive lead, to ensure correct operation with CMOS. This doesn't place U1a at any risk of damage, however, as even when R7 is connected via SW1, there is still 33k of series isolation between pin 9 of U1 and the positive lead.

D1 and D2 are clamp diodes, to ensure that the probe input cannot take the inputs of U1a and b more positive than the positive supply rail, or more negative than the negative rail. Resistor R3 in turn protects the diodes from damage.



A closer view of the probe, showing the display LEDs and the two slider switches used to set the operating modes.

So that's how the probe works. Elegant, isn't it? Now let's look at what's involved in putting it together.

Construction

All of the probe circuitry and components are mounted on a small PC board, measuring 132 x 22mm and coded ZA-1447. As you can see from the photographs, the board fits snugly inside a neat moulded probe casing, whose external dimensions are 182 x 26 x 17mm (not including the probe tip.

The PCB is single sided, with all components mounted on the top. SW1 and SW2 and miniature slider switches, which attach to the board via small lugs which are passed through holes in the board and soldered on the copper side in the same way as the actual contact pins. LEDs 1, 2 and 3 mount directly on the board, but spaced up so that like the switches they protrude through holes in the case 'front panel'.

The construction is quite straightforward, although care needs to be taken during assembly due to the small and

PARTS LIST

Miscellaneous

1 Probe case and tip
1 Power lead with spring mini clips
1 Pre-punched panel insert
2 SPDT mini slider switch

Resistors

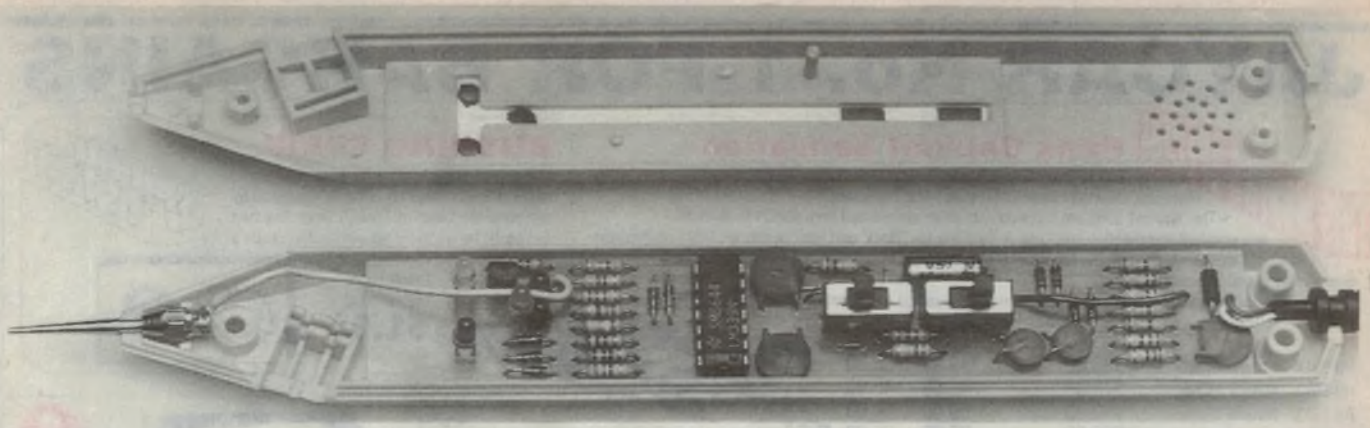
All 1/4W:
3 22 ohms (R12,13,15)
1 1.2k (R19)
3 4.7k (R3,8,10)
1 33k (R4)
1 47k (R7)
1 56k (R5)
5 120k (R6,14,16,18,20)
1 390k (R2)
4 820k (R1,9,11,17)

Capacitors

2 1nF ceramic (C3,4)
3 0.1uF ceramic (C1,2,6)
1 1uF 16V min. electro (C5)

Semiconductors

9 1N4148 diode (D1-9)
1 1N4004 (D10)
3 3mm red LED (LED2,4,5)
1 3mm green LED (LED1)
1 3mm yellow LED (LED3)
1 BC548 transistor (Q1)
1 LM339 quad comparator (U1)



Inside the case, showing how everything fits in.

compact nature of the probe. Note that there are two short wire links underneath U1, which must be fitted before the IC itself. There are three other short links, one adjacent to C1, one next to SW2 and the other alongside C5. There's also a longer insulated link that runs from near SW1 to a point alongside D10, and an insulated wire that connects from the PCB to the probe tip.

The four short links should all be fitted to the board before any components are added, but the two longer wires may be left until last.

The internal case height does not allow the components to be mounted too high off the PCB, so ensure that all except the three display LEDs – and the slider switches – are pushed down against the board before they are soldered into place. This includes the two 'regulator' LEDs 4 and 5, and transistor Q1 – which should be pushed down as far as it will go without putting undue strain on its leads.

The height of the three display LEDs is important, as if the leads are too long the case will not fit together. Ideally they should protrude slightly through the cover so they can be easily seen, so that the bottom of the bodies should be about 6mm above the top of the PCB. It may be best to leave these until last before soldering them in place.

Apart from these points, assembling the board should follow the usual course. After the short links the resistors should be fitted first, followed by the capacitors and diodes – taking care to fit C5 and the diodes with the correct orientation. Then you can fit the two slider switches, Q1, the two regulator LEDs and the IC – taking care again with orientation. Finally add the three display LEDs, with the correct spacing; a green one is used for LED1 (Lo), a red one for LED2 (Hi), and a yellow one for LED3 (Pulse).

Next you can fit the long insulated wire link, and also the lead for the probe tip. The latter should be cut to about 70mm long overall, with 4mm of insulation removed at each end for the connections. The far end can be soldered to the rear of the tip, taking care to make a good joint.

The final step is the connect up the power supply cable, to the far end of the board. Then you're ready to fit the PCB assembly into the plastic case.

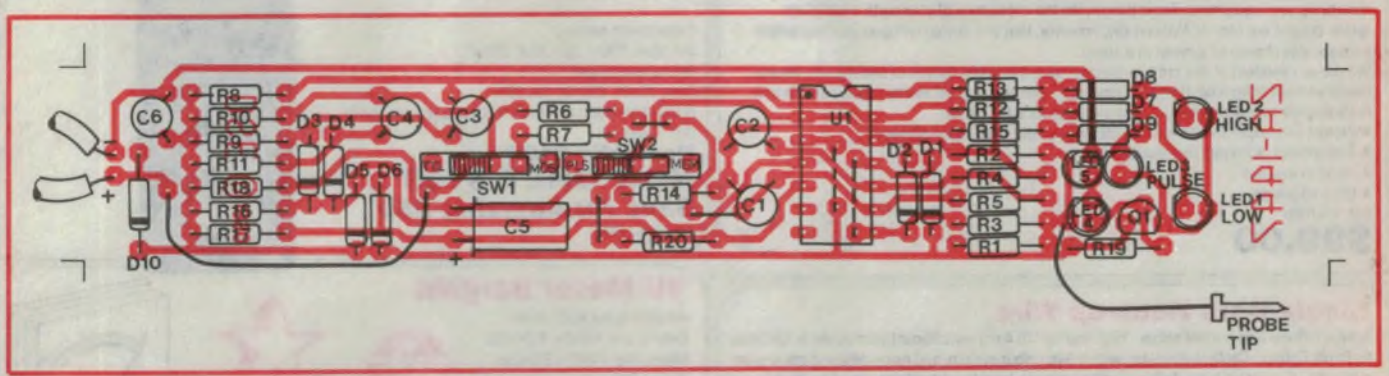
Note that on the inside of the top of the case, near the centre, there are two small spigots. The one closest to the probe end will interfere with R1 or R3, so cut this spigot off before trying to fit the case together. The pre-punched insert for the 'front panel' can be mounted before the case is finally fitted and screwed together.

That's all there is to it. Providing you've been careful in putting it together, your logic probe should work first time without any problems. If it doesn't, the odds are that you will have fitted C5, one of the diodes, one of the LEDs, Q1 or U1 with the incorrect polarity – so it pays to check these carefully while you're doing it, to save hassles later.

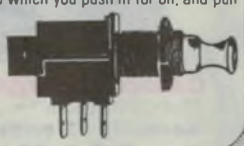
In operation, the only things to remember are (a) to make sure that the probe power connections are made to the supply rails of the board you're using it to check; and (b) to move SW1 to the correct position, according to the type of logic circuitry you're checking.

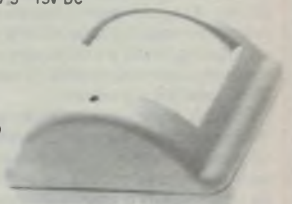
The only other point to note is that with SW2 in the 'Pulse' position, LED3 will indicate a 'stretched' version of pulses – regardless of their polarity. In the 'Memo' position it will stay on following a pulse, again of either polarity, until you flick SW2 briefly back into the 'Pulse' position.

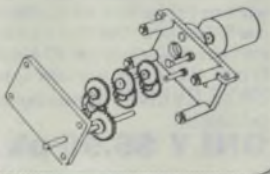
Happy troubleshooting!

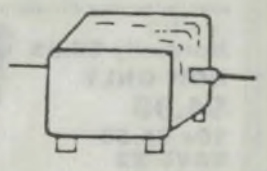


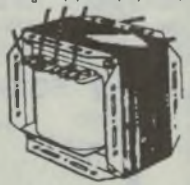
And finally, here's the PCB overlay diagram, showing the location and orientation of all parts on the board itself. Don't forget the two links under U1, and the three other short links.

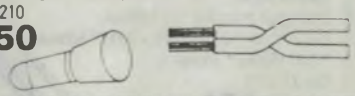


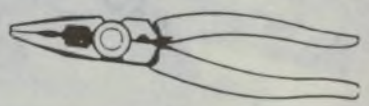


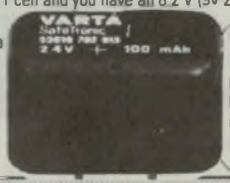












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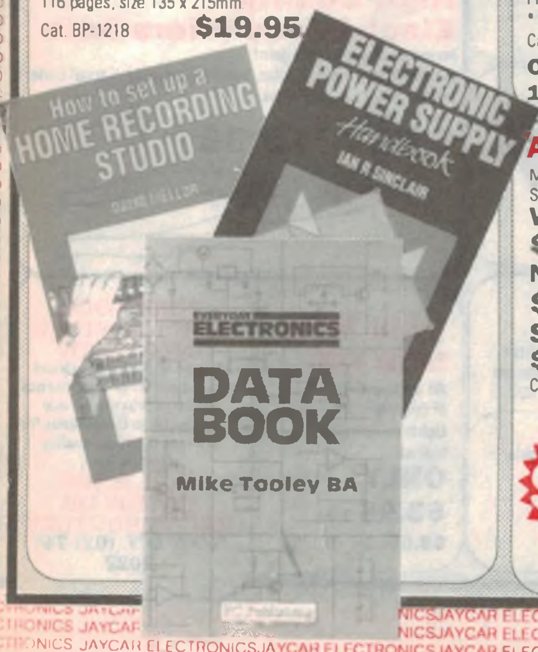

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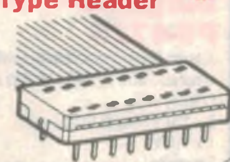

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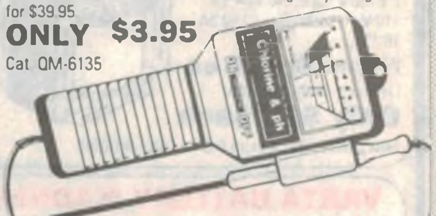

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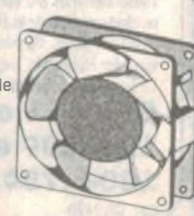

SINE/SQUARE WAVE GENERATOR

Ref: Silicon Chip August 1990

This new Digital Sine/Square Wave Generator uses high speed CMOS and a digital filter IC to produce sine and square waves over a very wide frequency range - from 0.1Hz to 500kHz.

Specifications:

• Frequency Range: 0.1Hz to 500kHz in four ranges - 0.1Hz to 10Hz, 10Hz to 1000Hz, 1kHz to 100kHz and 100kHz to 500kHz. • Output Waveforms: Sine and Square • Harmonic Distortion: Less than 0.1% from 0.1Hz to 50kHz, 0.27% at 80kHz • Square Wave Rise Time: 10ns • Square Wave Fall Time: 10ns • Output Level: Sine wave variable from 0-1.2Vrms; Square wave variable from 0 to 5V p-p • Output Impedance: 600 ohm nominal • Load Impedance 600 ohm to infinity • Protection: Short circuit protected (indefinite) • Display Accuracy: (pm) 2% (ps) 1 digit

The Jaycar kit includes PCB, box, punched and screen front panel and all specified components.

Cat. KC-5079

$179.50

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Ref: Silicon Chip August 1990

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VOLTUP KIT
A 1.5 to 9V DC/DC converter

Ref: EA May 1990

Replace those expensive 9V batteries with an economical 1.5V D cell. Lasts much longer and saves you the cost of the kit in no time. Shortform kit - PCB, potcores, battery holder, heatsink and all electronic components supplied (excluding optional receiver parts). No box or box hardware supplied.

Cat. KA-1724

ONLY $19.95

±50V (0-100V) 1.5A Dual Tracking Power Supply Kit

Ref: Silicon Chip April '90

This kit features high efficiency toroid power transformer, professional high resolution 10-turn wire wound voltage control potentiometer, latest I.C. technology, excellent line load regulation, low ripple voltage, apart from a smart plastic case! (for more information see specs below)

The Jaycar kit is complete down to the last nut and screw as well as all hard-to-get I.C.'s.

Cat No. KC-5073 **$229**

High Energy Ignition for Cars with Reluctor Distributors

Refer silicon Chip May 90

Designed for cars with Reluctor distributors, this ignition kit features improved protection for the coil and main switching transistor.

Kit includes PCB, die cast box and all components to finish the kit.

KC-5076

$46.95

Power Supply Load Protection Kit

Refer Silicon Chip June 90

This add-on board prevents dangerous voltages from being delivered to a load by any dual trackng power supply when it is turned on or off.

Short form kit. Includes PCB, relay and all specified components.

Cat. KC-5078 **$17.95**

Low Noise Universal Pre Amp Kit

Refer Silicon Chip June 90

Ideal for a magnetic cartridge, tape player or microphones. Shortform kit, includes PCB switch, cable and all electronic components.

No box front panel or panel hardware supplied.

Cat. KC-5077

$32.95

1pF - 9999uF Capacitance Meter Kit

Cat. KC-5075 **$109**

Refer Silicon Chip May 90

This attractive 4 digit capacitance meter kit is designed for workshop, laboratory or serious hobbyists. It can measure capacitance from 1pf up to 9999uf in seven ranges with an accuracy of better than +/- 1% +/- 1 digit. Kit is complete with all components required to finish construction.

Jaycar ELECTRONICS

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Construction Project:

Improved Programmable Combination Lock

What! Not another keypad entry combination lock you say! No – this one has numerous features over others published before. In particular it stores the entry code in a memory, allowing the code to be changed. The unit can also be used to trigger or even arm or disarm an existing security alarm. It's cheap, easy to build and the onboard relay can control loads of up to 10A.

by JEFF MONEGAL and PETER PHILLIPS

Protect your home or car with this programmable combination lock. The unit allows you to change the entry code, and it can interface to an alarm system as well.

Digital combination locks offer several advantages over conventional locks and keys. You can't lose them, you can't steal them, they can't be picked and, in our version, the entry code can be easily changed. The only disadvantage is that you must remember a numeric code. And in the age of the PIN number, this is something most people have become accustomed to.

With our new programmable combination lock, you program it with a four-digit code to open the lock and another four-digit code is used to put the lock into program mode. When in program mode eight digits are entered in all, of which the first four digits make up the new 'open lock' code and the last four become the new 'enter program mode' code. What could be simpler?

In case of power failure, a backup battery is available to power the circuit, and as the recommended battery is a 1.2Ah rechargeable type, enough power is available to operate a door lock solenoid as well. In normal operation the internal battery is trickle charged by the onboard charging circuit, keeping the battery ready for emergencies.

The lock can also be used in a house (or a car) to arm or disarm a security system. For example, the lock can be wired to not only open the front door, but to also disarm the burglar alarm system on entry, taking the worry out of false alarms if you aren't quick enough with your manual disarming.

Or perhaps you have a motorised garage door or gate, that could use an extra means of control.

Its main purpose is to act as an electronic 'key', and the applications are numerous – including, of course, use with a conventional door lock solenoid via the onboard relay.

As shown in the lead picture, the unit comprises a keypad connected with ribbon cable to a box containing the electronics. The key pad would usually be fitted at a point convenient to the door, being protected from the weather, while the electronics is placed somewhere out of harm's way. For added security, you could even include two extra wires in the ribbon cable, connected as a loop to your alarm system. This way, if someone cuts the cable in an attempt to break in, the alarm will be triggered.

How it works

The circuit looks rather complicated, but is easy enough when broken into sections. There are two modes of operation; 'program' mode and 'operate' mode. We'll describe the program mode first, as programming the unit is required before it can do anything.

When power is first applied, two power-on reset circuits put the circuit into program mode. Power-on reset will only occur when the unit is first turned on, or if the power has been off for a few days and the back-up battery has gone flat, requiring power to be restored to the circuit. Under these conditions, a positive (logic 1) reset pulse is applied to pin 1 of the address counter IC5 and also to pin 15 of the 'correct key' counter IC7, as a result of C6 charging through R9. Once C6 has charged, R9 will hold the reset pins of both IC5 and IC7 low.

The second reset circuit is that pro-

vided by C7 charging through R20. This circuit applies a logic 1 to pin 8 of IC8c, causing output pin 10 of the flipflop comprising IC8c and IC8d to be reset to a logic 0. The other output (pin 11 of IC8d) will be set to a high. The logic 0 at pin 10 puts IC4, the 2114 memory IC, into write mode (logic low level at pin 10 of IC4) and enables the tri-state buffers of IC3 (IC3a to IC3d).

IC4 is a 1024 x 4 bit static RAM, in which only the first 16 addresses are used, as selected by address pins 4 to 7. Pin 11 of the flipflop (IC8d) will disable both the 'wrong key' counter IC6 and the 'correct key' counter, IC7 by placing a high at pin 13 of both ICs. The unit is now in program mode.

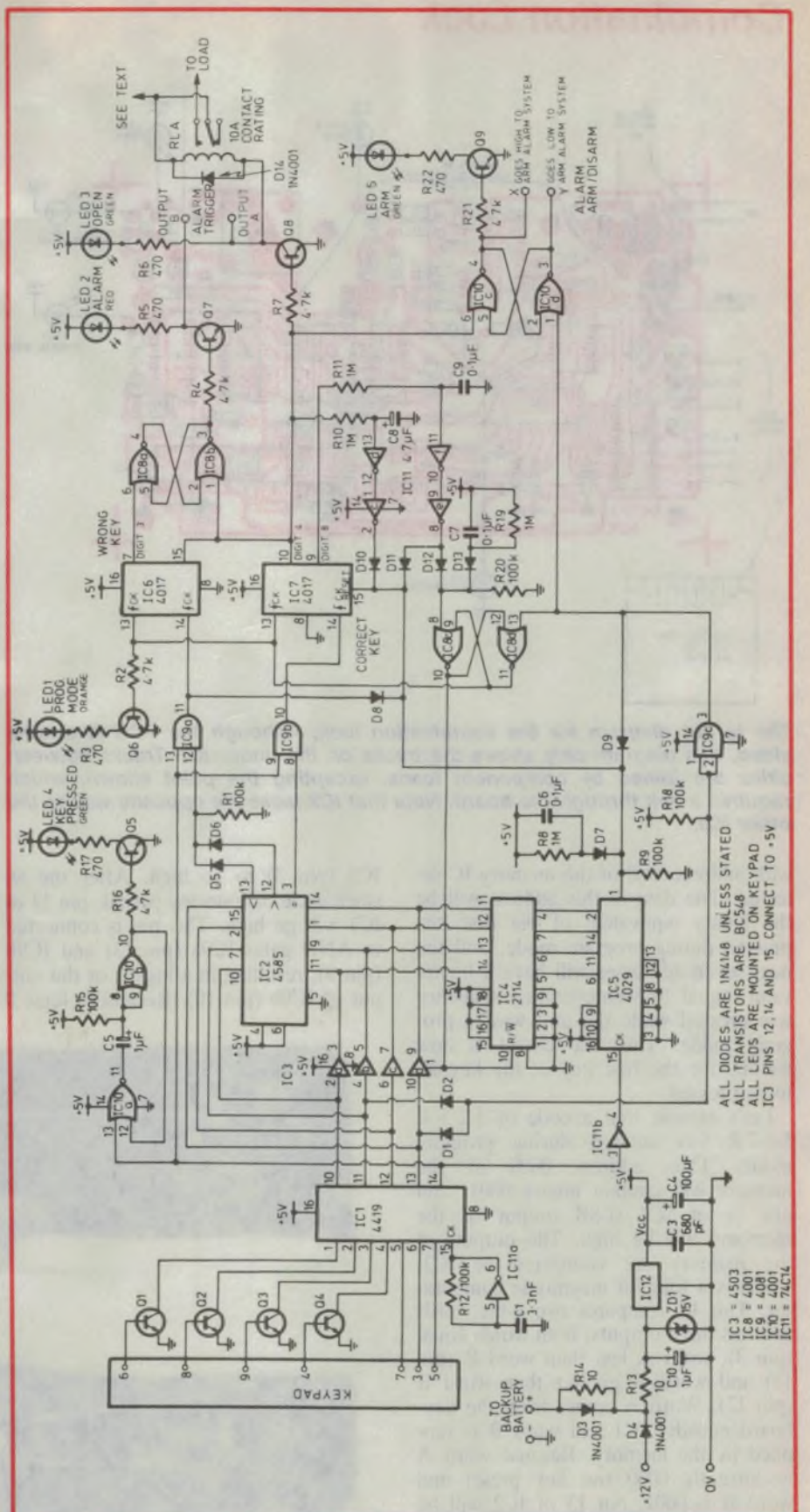
IC1 is a two-of-eight keyboard to binary encoder. When any key of the keypad is pressed, the equivalent binary code for that key will appear at output pins 10 to 13. Pin 10 is the least significant bit (LSB) of the code. This code is placed on the input/output lines of the memory IC, (IC4, pins 11 to 14) via the tri-state buffers of IC3, and is stored in the memory, as the memory is in write mode.

After 80 clock cycles following the last key press, (debouncing period) a positive output pulse occurs at pin 14 of IC1. This pulse clocks the address counter IC5, to the next memory address location. When another key is pressed the whole process is repeated. After eight key presses, the cycle needs to be ended by pressing either of the system reset keys, marked '#' and '*'.

When either of these keys is pressed, diodes D1 and D2 will be reverse biased, causing a high at the inputs of AND gate IC9c via pullup resistor R18. This gate is a buffer and will therefore output a logic 1 at pin 3. This resets the address counter IC5 back to 0000, and causes pin 4 of the flipflop comprising IC10c and IC10d to be set to a logic 1. This output can be used to arm an existing alarm system if required, and the 'Arm' indicator LED gives a visual indication of the status of this output. The 'Arm' condition can only be reset by entering the 'unlock' code.

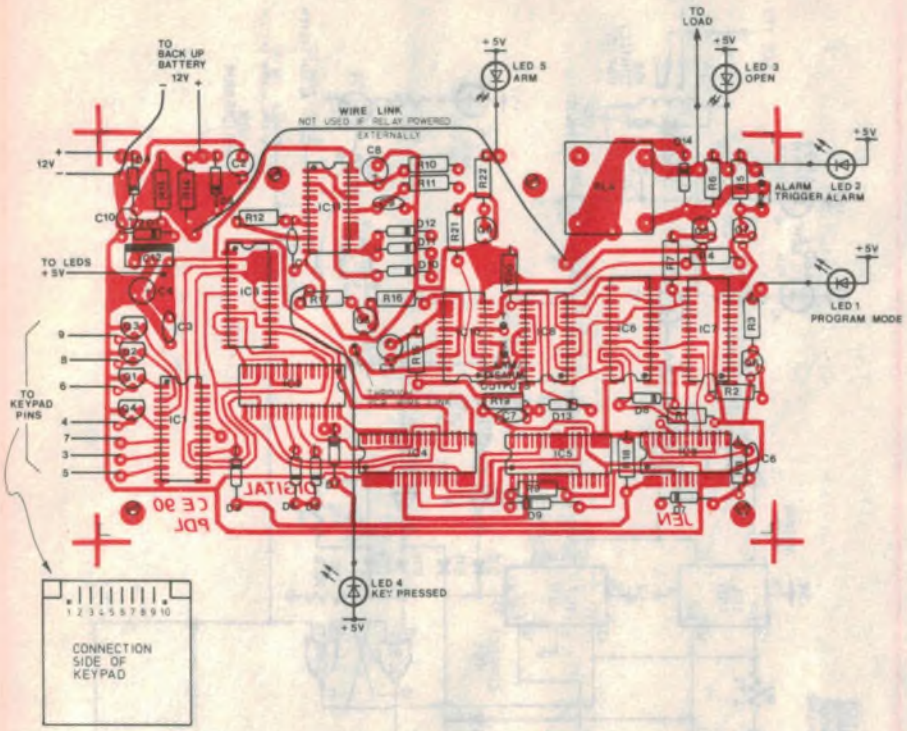
The high at pin 3 of IC9c also resets the program mode flipflop of IC8c and IC8d, in which pin 10 of IC8c goes high, enabling the 'wrong key' and the 'correct key' counters (IC6 and IC7 respectively). The tri-state buffers of IC3 are also disabled by the high at pin 10 of IC8c, by returning them to their high impedance mode. It also sets the memory IC4 to read mode, as the R/W-bar input (pin 10) will now be a high.

The circuit is now in 'operate mode',



The circuit for the combination lock uses a static RAM to hold the codes. The keypad connects via seven lines to IC1, which outputs the binary code for each key.

Combination Lock



The layout diagram for the combination lock. Although the PCB is double sided, this diagram only shows the tracks on the underside. Tracks between sides are joined by component leads, excepting the point shown, which requires a link through the board. Note that IC2 faces the opposite way to the other ICs.

with address 0000 of the memory IC selected. The data in this address will be the binary equivalent of the first key pressed during program mode, and the next seven addresses will have a binary value equal to whatever key sequence was pressed while the unit was in program mode. Thus the circuit is now waiting for the first key of the keypad to be pressed.

Let's assume that a code of 1-2-3-4-5-6-7-8 was entered during program mode. Thus address 0000 of the memory will contain binary 0001, and pin 14 of IC4 (LSB output of the memory) will be high. The outputs of the memory are connected to IC2, which is a four bit magnitude comparator. This IC compares two 4-bit words and has three outputs; both words equal (pin 3), word A less than word B (pin 13) and word A greater than word B (pin 12). Word A comes from the keyboard encoder IC1 and word B is supplied by the memory. Because word A is currently 0000 (no key press) and word B is 0001, pin 13 of IC2 will be high.

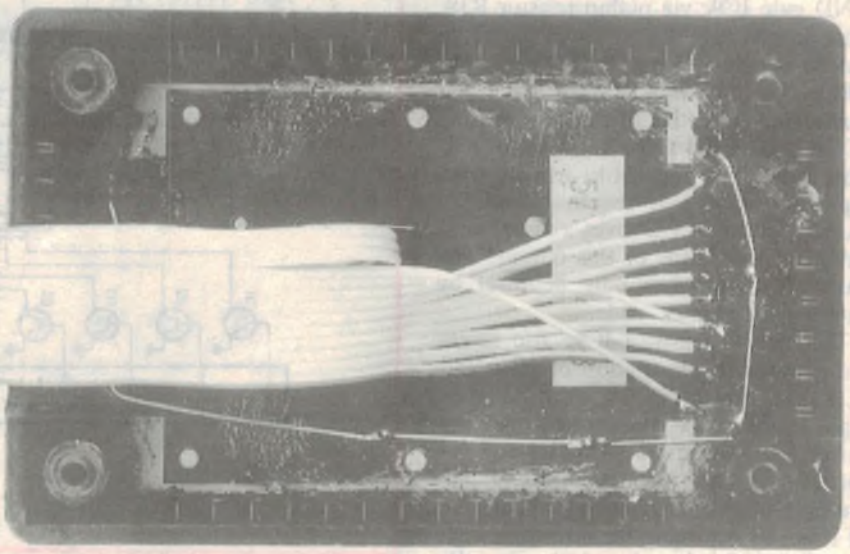
If the numeral key '1' on the key pad is pressed, words A and B will be equal, causing the 'equals' output of IC2 (pin 3) to go high. After the 80 clock cycle debouncing period, pin 14 of IC1 will go high. This pin is connected to AND gates IC9a (pin 13) and IC9b (pin 9), resulting in a logic 1 at the output of IC9b (pin 10). Because a logic 0 is applied to input pin 12 of AND gate IC9a from either pin 12 or 13 of IC2, the output of this gate (pin 11, IC9a) will be a logic 0. As a result, the 'correct key' counter IC7 will be incremented by one count. The same thing will happen as long as the next three key presses are the numerals 2, 3 and 4.

If an incorrect number is entered, word A will be different to word B, and IC2 will output a logic 1 at either pin 12 or pin 13, depending on whether word A is less than or greater than word B. This will clock the 'wrong key' counter, IC6, as under these conditions, pin 11 of IC9 will go high when the strobe output (pin 14) of IC1 goes high. The logic 1 from IC9a (pin 11) will also reset (to 0000) the address counter (IC5) and the 'correct key' counter (IC7) via diode D8. Thus, if an incorrect key is pressed, the user has to start all over again.

However, after three false tries, output pin 7 of the 'wrong key' counter (IC6) will go high, setting pin 3 of IC8b to a logic 1, turning on Q7 and lighting the 'alarm' LED. The collector of Q7 will fall to zero volts under these conditions, and this negative transition can be used to trigger an alarm system if required.

The only way to turn off the 'alarm' LED is to enter the correct four-digit code, and no warning is given prior to the third attempt, giving excellent security.

If on the other hand the correct four-digit code is entered, pin 10 of the 'correct key' counter, IC7 will go high. This does a number of things. First, the 'wrong key' counter IC6, is reset by the logic 1 at its reset input (pin 15). Also,



The keypad and LEDs connect to the main PCB with a 13-wire ribbon cable, as shown in this photo. Use silicone glue to fix the LEDs and the keypad to the box, which needs a rectangular cutout for the keypad.

Q8 will be turned on, operating the 'open' LED and the relay, which drives the door lock solenoid.

Timing capacitor C8 is also connected to pin 10 of IC7, and it will charge via R10. When the voltage across this capacitor has charged sufficiently (after around two seconds), the level at pin 13 of IC11d will equal a logic 1, causing a logic 1 to appear at the reset pin (pin 15) of IC7. This will reset the counter, turn off Q8, the 'open' LED, the relay and the door lock solenoid, and the circuit re-enters its normal operating mode awaiting the next input code.

If you wish to go into program mode, then the fifth key press must occur before the two second timer has finished. After the remaining three digits of the entire eight digit code have been entered, pin 9 of IC7 will go high, sending pin 8 of IC11e high. This will set pin 10 of IC8c to a low, and the unit is now in program mode as previously described.

As before, if a wrong key is pressed during the 'program code' the entire eight digit code must be re-entered. If three wrong keys occur in the program code, (digits 5 to 8), the alarm condition will occur.

The clock signal for IC1 (pin 15) is provided by the oscillator formed by IC11a, R12 and C1. The keyboard uses a standard three-by-four matrix to code each key, and transistors Q1 to Q4 are required to interface the keyboard to IC1.

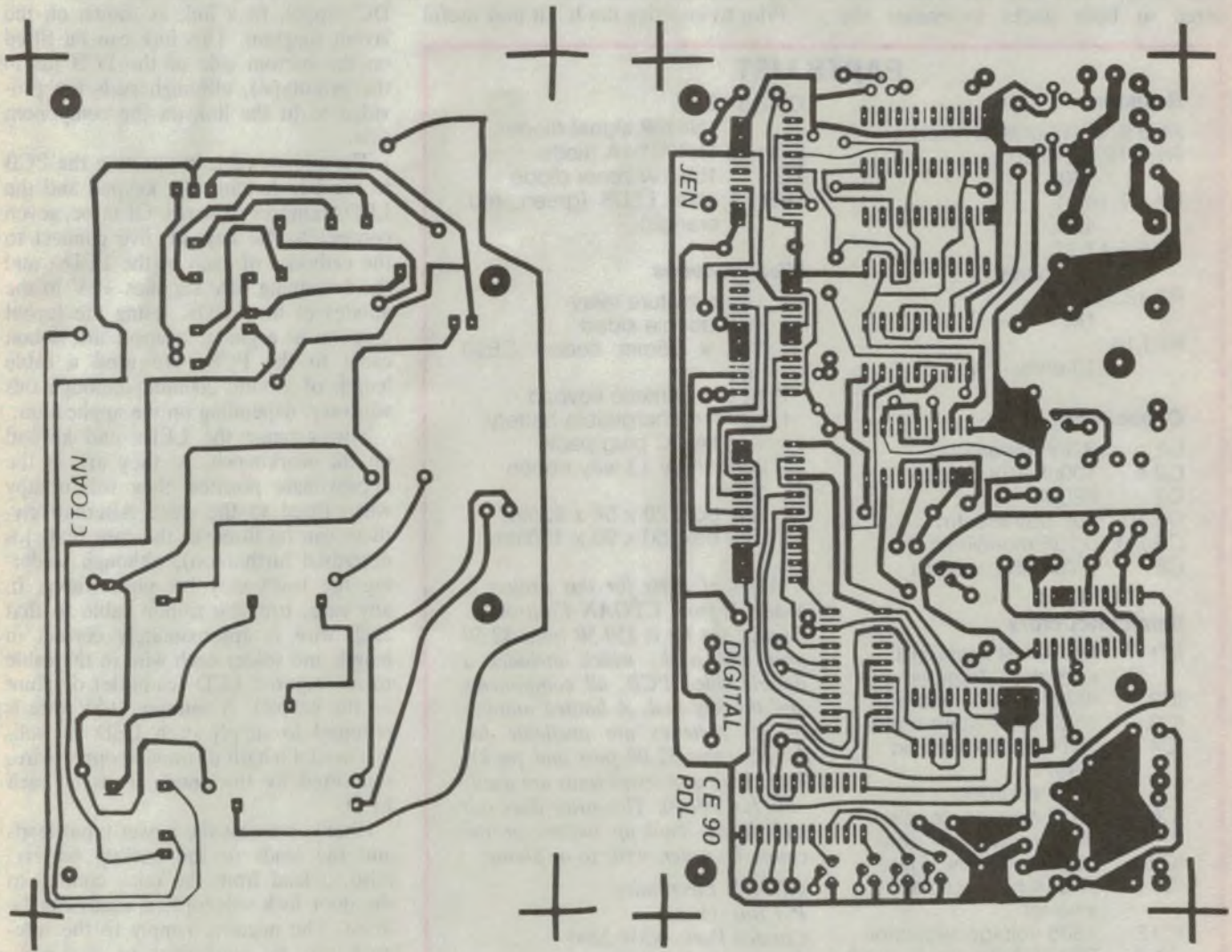
To give visual feedback of a key press, the output pulse at pin 14 from the keyboard encoder IC1 is fed to a timer comprising IC10a, IC10b, R15 and C5. As already described, a positive pulse occurs at pin 14 of IC1 after 80 clock cycles, and this pulse is used to trigger the timer, which effectively stretches the pulse, lighting the 'key pressed' LED via transistor Q5.

Power to the circuit is either from an external 12V supply or, in the event of power failure, from the 12V backup battery. Diode D4 isolates the incoming mains derived DC supply from the backup battery when the mains fails. The network comprising C2, C10, R13 and ZD1 provide suppression of any noise on the DC input, and IC12 regulates the 12V input down to the required 5V. Noise suppression on the 5V rail is provided by C3 and C4. The backup battery is charged via R14, and D3 allows the battery to power the circuit when the mains fails. The recommended battery will last in excess of 24 hours under normal conditions.

Construction

A kit of parts for this project is available from CTOAN Electronics for $59.50. (See details at end of this article).

The PCB is double-sided, and some of the tracks are connected between sides with component leads, including the leads of some of the ICs. For this reason, IC sockets are difficult to fit,



The artwork for both sides of the PCB is reproduced full size for those who wish to make their own.

unless wirewrap or similar types that allow soldering on both sides of the PCB are used. Alternatively, Molex IC socket strips could be fitted. You will need a soldering iron with a fine tip, and if you solder the ICs directly to the PCB (as in the prototype), earth the tip of the iron, as most of the ICs are CMOS types. (By the way, CTOAN will construct the unit for you if required – details at end of article).

The first task is to inspect the PCB. Because some of the tracks pass between IC pins, examine the PCB under a magnifying glass, just to be sure there are no manufacturing problems – particularly with shorted tracks. Spend some time with this, as any problems found now will save considerable time later on.

Commence construction by fitting the resistors and capacitors. Where a component lead passes through a track on both sides, make sure the lead is soldered to both tracks to ensure the tracks are joined. Check that the polarity of all electrolytic capacitors is correct before soldering them in place.

Next fit and solder the diodes. Check carefully that all diodes are correctly orientated, and again check that you solder on both sides of the PCB if tracks are being joined by a diode lead.

The eight transistors can now be fitted to the PCB. All transistors are the same type, and none require soldering to both sides of the PCB. The relay can also be soldered in place, leaving only the ICs and the ribbon cable to go.

As already said, the usual type of IC sockets cannot be used because of the solder joins required on the component side of the board. If you elect to use a type that will permit soldering top and bottom, then these can now be fitted and soldered. Otherwise, insert each IC in turn, and solder (on the underside of the PCB) only those pins that are used. Then inspect the component side of the board and solder those pins that connect to a track on this side.

Prior to inserting the IC, it may useful to mark the points that need soldering on the component side of the PCB, as some tracks pass under the IC, making it difficult to see which pins need soldering on the component side. Do the soldering fairly quickly, to prevent overheating the IC. Because most of the ICs are CMOS, the soldering iron tip should be earthed to prevent static discharge damaging the IC. Note that IC2 (4585 comparator) faces the opposite way to the other ICs. The voltage regulator IC12 has one connection soldered both sides (the 5V output terminal).

It remains to connect the ribbon cable, the power leads and (if required) a link to power the relay. As shown on the circuit diagram, the common contact of the relay is connected to the supply for the relay coil, allowing the load connected to the relay to be driven by this supply. For this reason the relay can be powered from either an external 12V DC supply, or from the 12V DC input powering the PCB. If you choose to power the relay from the PCB's 12V DC supply, fit a link as shown on the layout diagram. This link can be fitted on the bottom side of the PCB (as in the prototype), although pads are provided to fit the link on the component side.

The ribbon cable connecting the PCB to the box holding the keypad and the LEDs requires 13 wires. Of these, seven connect to the keypad, five connect to the cathodes of each of the LEDs, and the remaining wire supplies +5V to the anodes of the LEDs. Using the layout diagram as a guide, connect the ribbon cable to the PCB. We used a cable length of around 200mm, although this will vary, depending on the application.

Now arrange the LEDs and keypad on the workbench, so they are in the approximate position they will occupy when fitted to the case. Alternatively, these can be fitted to the case first, (as described further on), although soldering the leads may be more tricky. In any case, trim the ribbon cable so that each wire is approximately correct in length and solder each wire in the cable to its required LED (cathode) or point on the keypad. A common +5V wire is required to supply each LED as well. We used a length of tinned copper wire, supported by the anode leads of each LED.

Finally, connect the power input leads and the leads to the backup battery. Also, a lead from the relay contact to the door lock solenoid (if used) can be fitted. The negative supply to the solenoid can be connected to the same point as the 12V negative input to the

PARTS LIST

Resistors

All 5%, 1/4W unless noted
R1,9,12,15,18,20 100k
R2,4,7,16,21 4.7k
R3,5,6,17,22 470 ohms
R8,10,11,19 1M
R13,14 10 ohms 1W

Capacitors

C1 3.3nF ceramic
C2,4 100uF 16V electro
C3 680pF
C5,10 1uF 50V electro
C6,7,9 0.1uF monolithic
C8 4.7uF 35V, electro

Semiconductors

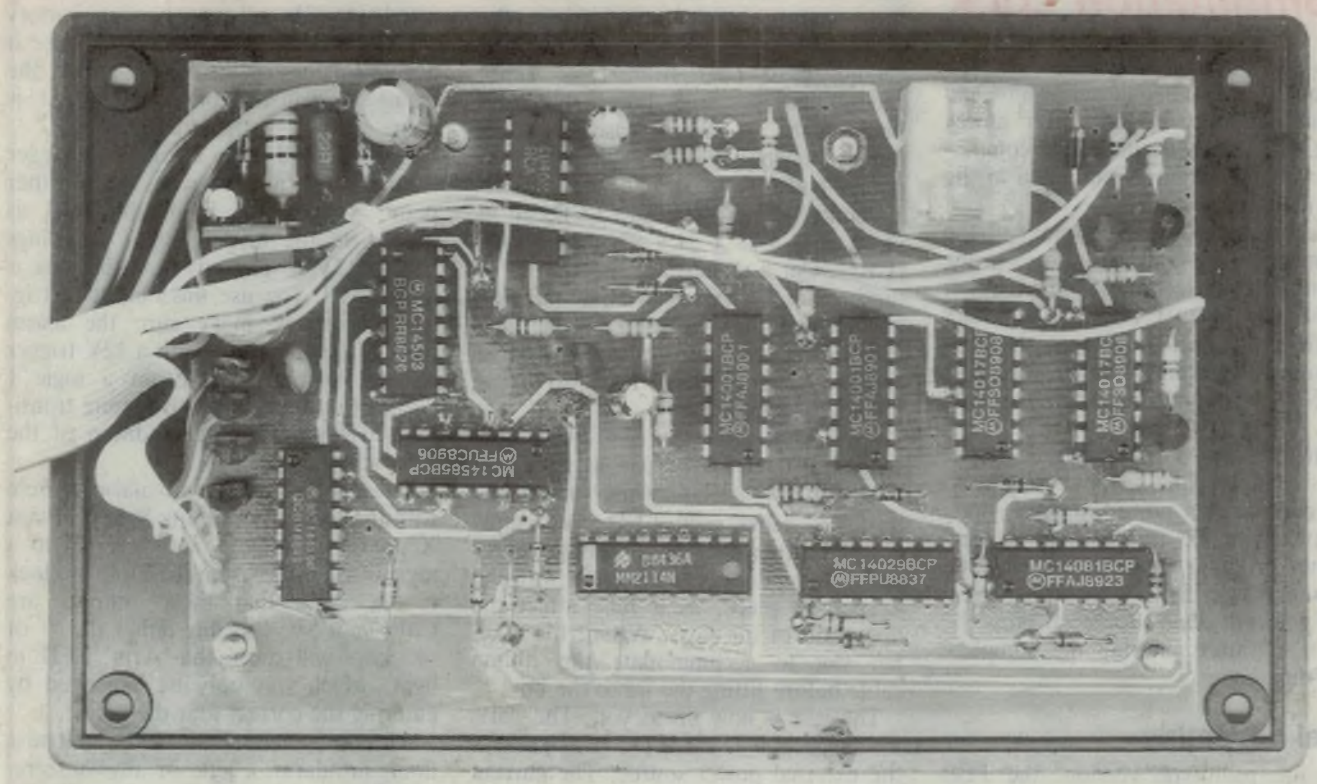
IC1 MC14419 keyboard encoder (Motorola)
IC2 4585 4 bit comparator
IC3 4503 three state buffer
IC4 2114-3 1K x 4 static RAM
IC5 4029 counter
IC6,7 4017 decade counter
IC8,10 4001 quad NOR gate
IC9 4081 quad AND gate
IC11 74C14 hex Schmitt inverter
IC12 7805 voltage regulator
Q1-9 BC548 NPN small signal
D1,2,5-13 1N4148 signal diode
D3,4,14 1N4001 1A diode
ZD1 15V 1W zener diode
LED1-5 3mm LEDS (green, red, orange)

Miscellaneous

1 12V miniature relay
1 PCB,double sided 128 x 75mm coded CE90 PDL
1 12 key numeric keypad
1 1.2Ah rechargeable battery
1 12V/1A DC plug pack
1 200mm by 13 way ribbon cable
1 Jiffy box, 28 x 54 x 83mm
1 Jiffy box, 50 x 90 x 150mm

A kit of parts for this project is available from CTOAN Electronics. Cost of the kit is $59.50 (plus $2.50 post and pack) which includes a double sided PCB, all components and the key pad. A limited number of gel batteries are available for $19.95 (plus $2.00 post and pack). Fully built and tested units are available for $99.90. This price does not include the back-up battery or the cases. To order, write to or phone:

CTOAN Electronics
PO Box 33
Condell Park, NSW 2200
Phone (02) 7083763



This photo shows the main PCB of the prototype. The PCB track patterns are now slightly different to the prototype, but the component layout has changed only slightly. The link to power the relay was fitted to the underside of the PCB.

PCB. Once all wiring and soldering is completed, carefully check everything for errors.

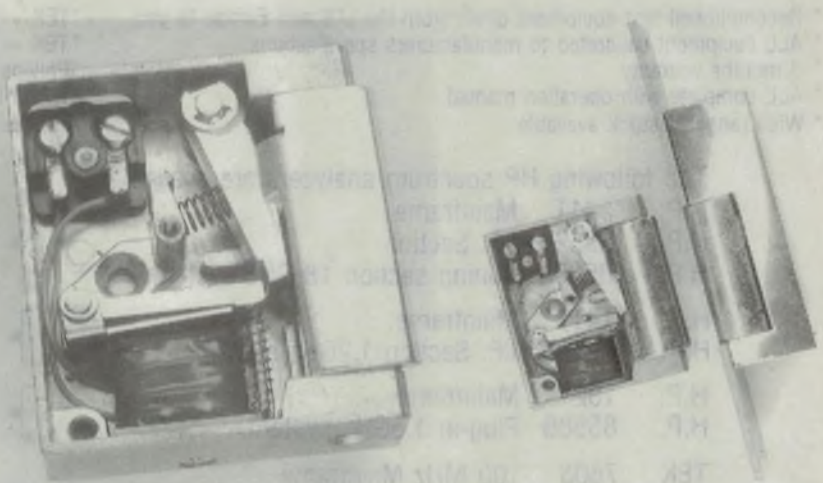
Testing

To test the unit, connect a 12V DC supply to the PCB and switch on the power. The current consumption should be around 80mA or so, and the 'Arm' and 'Program' LEDs should both light. If not, try disconnecting then reconnecting the power, to get a power-on reset condition. Pressing any number key on the keypad should cause the 'key' LED to briefly light. If none of the above occur, make sure that the regulator is supplying 5V to the circuit. Correct if necessary.

Otherwise, faultfinding will require the use of a logic probe connected to the 5V rail and ground. Check that there is a clock signal at pin 15 of IC1, and that pin 14 of this IC gives a pulse output after each key press. If so, go through the circuit with the logic probe, looking for logic errors. Typical problems will include IC pins not soldered (check those on the component side of the board in particular), ICs or diodes around the wrong way, and so forth. We constructed several versions, and all worked without any problems.

If everything seems to be working so far, reset the circuit by momentarily disconnecting the power. Then enter any eight digit code, followed by a press on either the '#' or '*' keys. The 'open' LED should light for a few seconds if the first four digits of the code are entered after the unit has been programmed. Also, the 'Arm' LED should extinguish. If neither of these LEDs react as described, try pressing the '#' or '*' keys prior to entering the code. If it still doesn't perform, get busy with the logic probe.

For example, confirm that the outputs (pins 10 to 13) of IC1 are all low when no key is pressed, and that they respond by giving the binary code for each press of a number key. After a power-on



These door lock solenoids operate at 12V and replace the section fitted in the architrave around the doorway. When the internal relay is energised, the door can be pushed open; normal operation with a door key is not affected. Those shown are courtesy of Oatley Electronics, and range in price from around $60 to $80.

reset, the address pins 4 to 7 of the memory IC (IC4) should all be low and should increment by one after a key press. The three outputs of the comparator should function as described in the 'how it works' section.

In short, study the description of the circuit operation, and use a logic probe to confirm each section of the circuit. If all else fails, then CTOAN Electronics will fix it for you as long as the construction is neat and complete. The cost is $25.00 maximum plus $2.50 post and pack.

When the unit is operating correctly, you should be able to enter an eight-digit code after a power-on reset, open the lock with the first four digits, and re-enter program mode by entering the remaining four digits before the 'open' LED goes out. Don't forget to press the '#' or '*' after entering the complete eight-digit code.

Final assembly

In the prototype version, the PCB containing the electronics for the lock was mounted inside a jiffy box, by attaching the PCB to the lid of the box with four screws and nuts. There are four mounting holes provided in the PCB, and a box measuring 50 x 90 x 150mm (size UB1 from Dick Smith Electronics) was used. File a relief slot between the lid and the case as an exit point for the ribbon cable and the power leads.

The keypad and indicator LEDs all fit nicely into a 28 x 54 x 83mm jiffy box (UB5). Cut a rectangular section out of the bottom of the box to allow the keypad to be fitted. We used silicone glue (Silastic or similar) to hold the keypad and the LEDs in place. This also serves to waterproof the box.

Drill 3mm holes for the LEDs, arranged around the keypad as shown in the photographs. Use white rub-on lettering to label each LED, and apply plastic lacquer over the lettering to protect it. Don't apply the lacquer with the keypad in place, as it may affect the operation of the keys. Again, file a relief slot to accommodate the ribbon cable before fitting the lid to the box.

The rest is now up to you. The parts list suggests a 12V/1A DC plug pack as the external power source. The current consumption of any load driven by the relay that is powered by this source should be included in the total load current, to ensure the plug pack is suitably rated. A 12V gel-type backup battery can be attached and tested, to ensure it not only powers the circuit when the mains is switched off, but that it is being charged by the circuit.

If you intend using the lock to trigger a burglar alarm, run wires from either point A or point B of the PCB as shown on the layout. Point A swings from +12V to ground when the lock is 'opened'. If you use this output to trigger the alarm, make sure the alarm module is compatible with a 12V trigger signal. Point B goes from a logic 1 (+5V) to ground (negative-going transition) when the alarm condition of the lock occurs.

To arm or disarm an alarm system with the lock, use outputs X or Y. Point X goes to a logic 1 and point Y to a logic 0 when the 'Arm' LED of the lock is on. Note that these outputs are CMOS, at 5V. Pressing either the '*' or '#' keys will cause the 'Arm' LED to light, which can only be cancelled by entering the correct four digit code.

All that remains is to fit the unit to a door, an alarm, a gate or anywhere requiring an electronic 'key', and you're in business. Just don't forget the code – you only get three chances!

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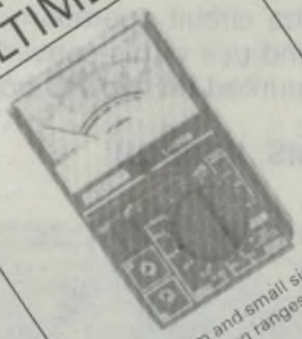

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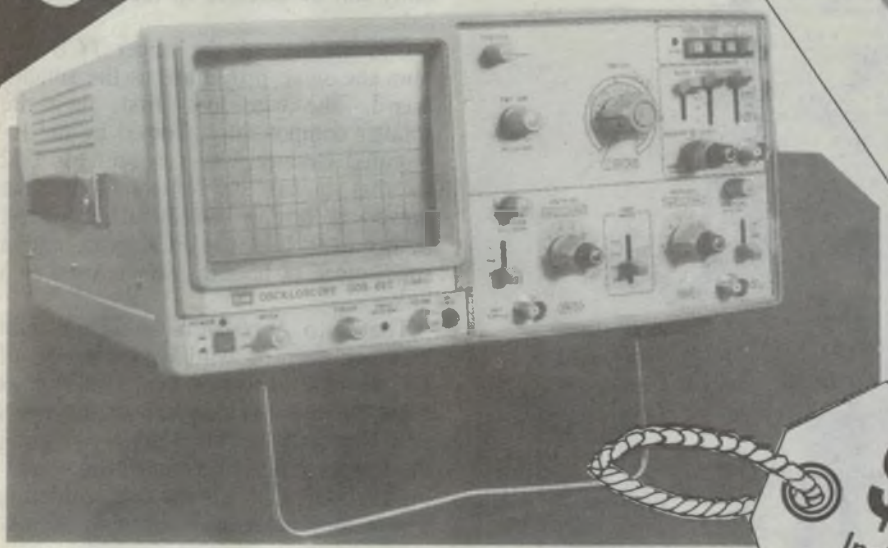

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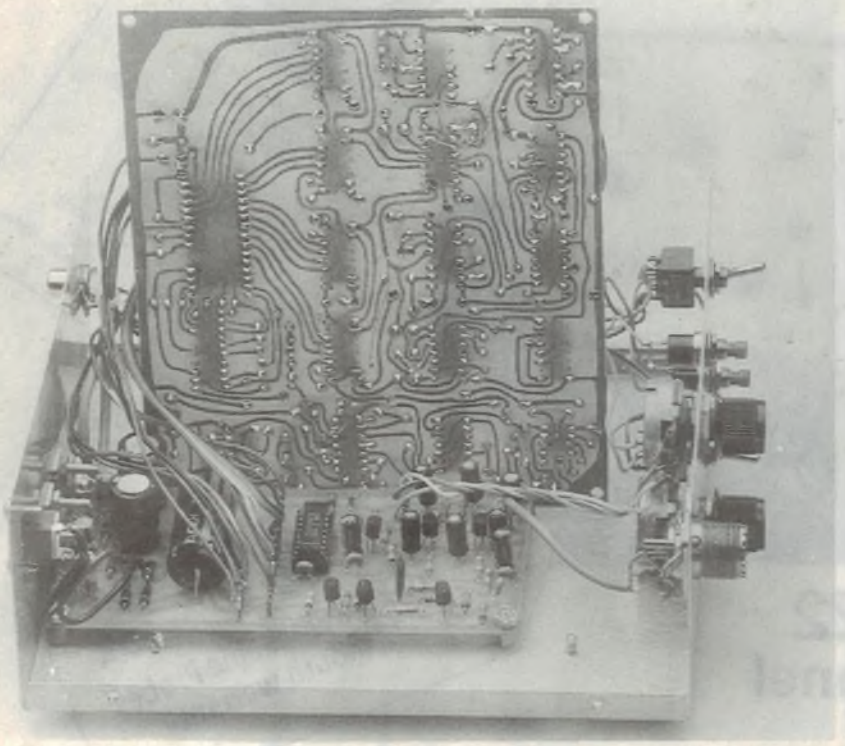
READER INFO No. 30

Construction Project:

SSTV Transmit Scanconverter - 2

Having described the circuit operation, our author continues this month with the construction, testing, alignment and use of his converter. He also discusses component supply choices. Most of the circuitry is mounted on two PC boards, to make assembly straightforward.

by LEON WILLIAMS, VK2DOB



Construction

The project is built on two printed circuit boards which are located in a small metal case. The smaller PCB (code 90sst7a) contains the video amp, sync separator, ADC and power supply and is placed in the bottom of the case. The larger PCB (code 90sst7b) contains the memory, address counters, control logic and the transmit circuit and is located above the smaller board.

Begin construction by assemblying the smaller board. Mount the wire links first, ensuring that they are straight and lay flat on the board. Then the resistors can be soldered in, followed by the PCB pins. PCB pins are used on both boards where an external connection is made.

The capacitors come next, remembering to double check the polarity of the electrolytics. I used an IC socket for the ADC, so that the IC itself can be left out until initial testing is completed.

Next the transistors and diodes are added, as well as the regulators. These are mounted so that their metal edge faces outwards from the board and their uncut leads only protrude through the PCB by 1 to 2mm. This allows the leads to be bent slightly outward so that the body can be screwed to the rear of the case.

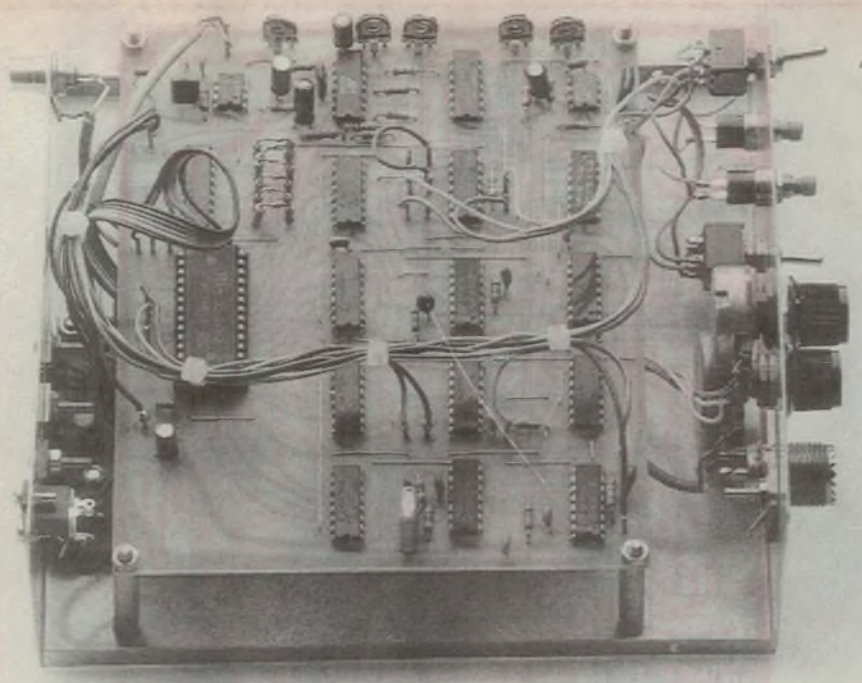
Construction of the larger PCB follows the same procedure as the smaller board. The wire links first, then the smaller components followed by the integrated circuits. Use a socket for U12 so that it can be left out until the power-up test is successful. The test points near U14 use PCB pins, and a small piece of hookup wire is used as a link.

The D to A resistors associated with U16 are formed with combinations of 1% or 2% resistors in series.This is done by inserting one end of the resistors vertically in their holes, soldering the lower ends in the board, then bending their upper leads inwards, soldering where they meet and trimming the excess.

With both boards complete the case can be drilled. There are five holes on the rear: one for the DC connector, one for the RCA audio output socket, and three for the regulators. Ensure that the regulator holes are clean and free from burrs. The location of these holes can be found by sitting the board on 6mm spacers and pushing it towards the back, marking the rear with a pencil through the holes in the heatsinks.

The bottom board is mounted on 6mm spacers, while the top board is mounted on a combination of 25mm and 9mm spacers. The height is governed by the spacing from the bottom of the top board to the top of the electrolytic capacitors below. The regulators are screwed to the rear using insulating washers and bushes.

Wiring can be done using small hookup wire for all connections, except



An inside view of the converter, with the larger of the two PC boards clearly visible along with the overall disposition of parts.

a small length of ribbon cable for the data bus between the boards. I used a small length of shielded audio cable between the larger board and the output socket. I also used the same type of shielded cable from the contrast control to the smaller board. The length is small and I see no problems with this. It is a good idea to run the wiring so that the top board can be lifted clear to gain access to the bottom board at a later stage.

Testing and alignment

With construction complete and IC's U1 and U12 stored safely aside, do a final check of your work. When you are satisfied all is well, plug in the plug pack and apply power.

Check the voltages at the outputs of the regulators. If they are not close to the required values, check for construction errors. Adjust all trimpots to halfway, solder a link between test points C (common) and N, and set the mode switch for continuous.

Plug your video source into the camera socket and connect an audio amp to the output socket. You should hear a constant tone, interrupted by a pulsing tone (horizontal sync). If you get something like this, remembering we have not yet done the alignment, then all is well and IC's U1 and U12 can be inserted after powering down.

Solder the test link between C and B/W (black/white). Turn the power on again and using a frequency meter, measure the clock frequency at pin 3 of U15, while adjusting VR3 for a reading of 2327Hz (approx). Now connect the frequency meter to pin 4 of U19, to measure the transmit frequencies.

Turn the contrast control almost fully anticlockwise – the reason for this is to provide the sync pulses to the control circuitry, but no video information. Turn the brightness control fully counterclockwise and push the snatch button. Adjust VR6 for a reading of 1500Hz. Now turn the brightness control fully clockwise, push the snatch button and adjust VR5 for a reading of 2300Hz. You may need to repeat this a couple of times until both frequencies are correct. Now connect the test link between C and S (sync) and adjust VR4 for a reading of 1200Hz.

Connect the test link between C and N (normal), turn the camera controls to midway, push the snatch button and listen to the audio amp. You should hear the picture being transmitted as a series of tones interrupted by the bursts of sync tone.

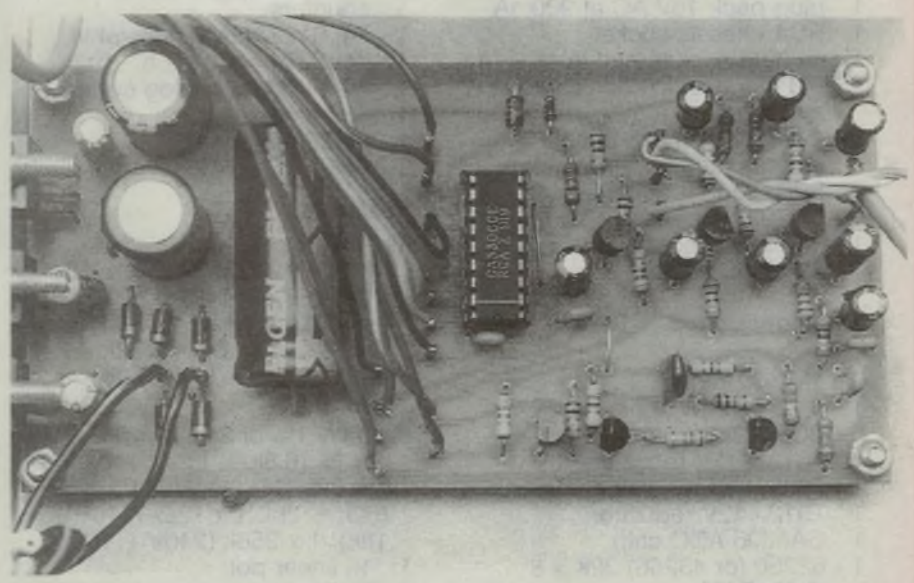
Assuming you have a receive scanconverter, you should be able to view your transmitted picture. But before you get too carried away in the excitement, there are a couple of things to check.

Throw the mode switch to single. 1200Hz should be permanently sent. Now push the start switch; one frame should be sent and then everything should stop. Throw the memory switch to the other position, snatch a picture and transmit it, checking that it is a new picture.

Experience will tell you the correct positions for the camera controls, as they will vary depending on light and subject material.

If you have not reached this point then something is wrong. To do further testing you will proably need an oscilloscope. By checking the signals at various points on the boards, any problems hopefully will become obvious.

Although I have not tried one, a colour camera may cause digitising prob-



Another view inside – this time a closeup of the smaller PCB with the larger one swung out of the way. The three voltage regulator chips are at left, bolted to the rear of the case.

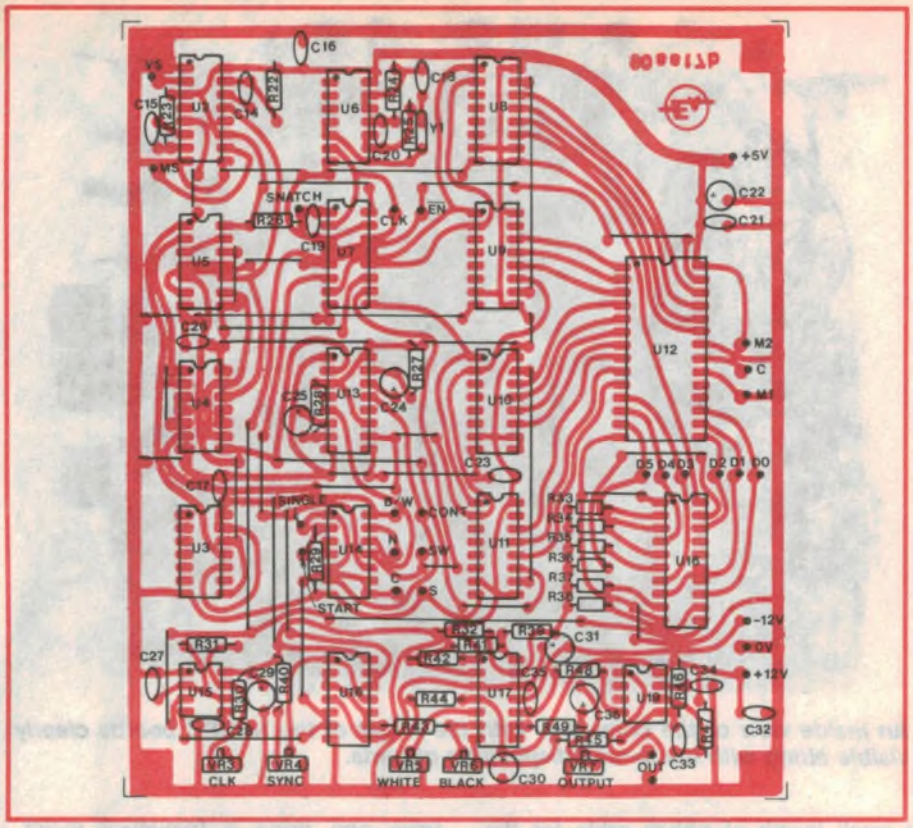
lems due to the presence of the chroma subcarrier. A trap comprising an inductor and a capacitor in parallel tuned to 4.433MHz could be placed between the camera socket and the contrast control, to null out the interfering signal.

Components

There should be no trouble in obtaining parts for this project as they are all standard components except for the ADC. I obtained my CA3306 from Radiospares in Sydney. The memory IC can be either a 62256 or a 43256 as I have tried both with success, one having an access time of 100ns and the other 120ns. I suggest you shop around for this item as you can buy them at a good price at some locations.

The plug pack is a bit overated: a 15V AC 500mA would suffice, but the one used is readily obtainable.

I used a SO239 socket for the camera input, as this is the standard type in my shack, but you could use any type to suit your video camera. I used inexpensive push buttons to help lower the overall cost, but a higher quality type would improve the performance, espe-



An overlay diagram showing the location of parts on the larger of the two PC boards, and also interconnection points.

PARTS LIST

- 1 metal case 184 x 70 x 160mm
- 1 PC board, 124 x 64mm, code 90sst7a
- 1 PC board, 148 x 120mm, code 90sst7b
- 1 plug pack 16V AC at 900mA
- 1 RCA chassis socket
- 1 camera socket (see text)
- 1 DC input socket (insulated) and plug
- 2 momentary make push buttons (see text)
- 2 SPDT toggle switches
- 1 3.579MHz crystal
- 1 18 pin IC socket
- 1 28 pin IC socket

Semiconductors

- 1 1N914 diode
- 6 1N4002 diode
- 1 5.1V 400mW zener diode
- 6 BC549 transistors
- 1 7812 +12V regulator
- 1 7805 +5V regulator
- 1 7912 –12V regulator
- 1 CA3306 ADC chip
- 1 62256 (or 43256) 32K x 8 static RAM
- 1 74LS221 dual monostable
- 1 74LS74 dual D type
- 2 74LS02 quad NOR
- 1 74LS00 quad NAND
- 1 74LS32 quad OR
- 1 74LS158 data selector
- 4 74LS161 synchronous counters
- 1 74LS123 dual monostable
- 1 74LS374 octal latch
- 1 4066 CMOS analog switch
- 1 555 timer
- 1 LM324 op-amp
- 1 566 VCO

Resistors

All 1/4W 5%:
1 x 22R, 2 x 270R, 3 x 470R, 2 x 1k, 2 x 1.8k, 3 x 2.2k, 1 x 3.3k, 9 x 4.7k, 1 x 6.8k, 7 x 10k, 2 x 15k, 4 x 22k, 3 x 27k, 1 x 47k, 1 x 68k, 1 x 330k.

All 1/4W 1% or 2%:
1 x 8k (6.8k + 1.2k), 1 x 16k, 1 x 32k (16k + 16k), 1 x 64k (62k + 2k), 1 x 128k (110k + 18k), 1 x 256k (240k + 16k).

- 1 1k linear pot
- 1 5k linear pot
- 1 1k vertical miniature trimpot
- 1 20k vertical miniature trimpot
- 3 10k vertical miniature trimpot

Capacitors

- 1 33pF ceramic
- 2 1nF greencap polyester
- 2 10nF greencap polyester
- 2 33nF greencap polyester
- 12 0.1uF monolythic ceramic
- 1 0.47uF 35V tantalum
- 1 4.7uF 35V tantalum
- 3 4.7uF 16V electrolytic PCB type
- 11 10uF 16V electrolytic PCB type
- 2 470uF 35V electrolytic PCB type
- 1 2200uF 35V electrolytic PCB type

Miscellaneous

2 knobs, 3 x T0220 insulating kits, PCB pins, ribbon cable, single core shielded cable, hookup wire, tinned copper wire, 4 x 6mm spacers, 4 x 25mm spacers, 4 x 9mm spacers, 9-3mm x 12mm screws and nuts, 4-3mm x 50mm screws and nuts, solder type earth lug.

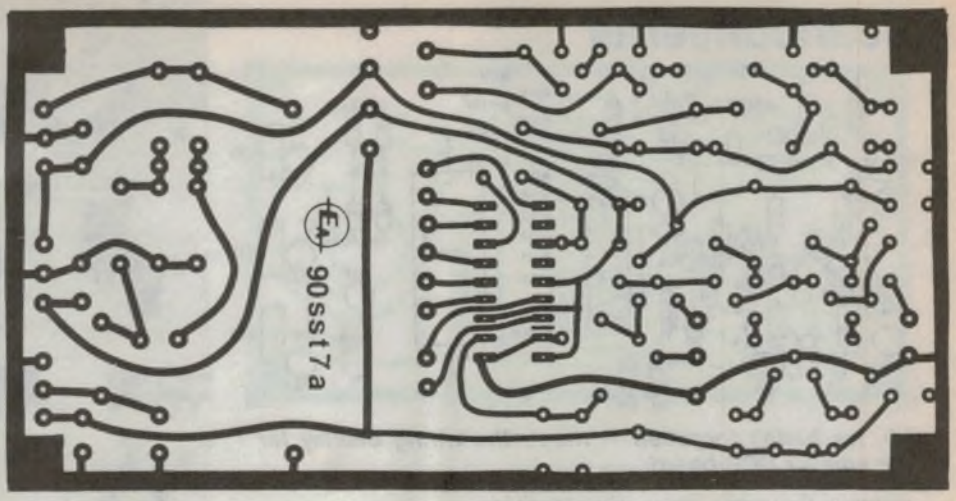
cially the snatch push button.

The plug pack is supplied without a plug, so you will need to add one. When choosing a mating socket ensure that it is completely insulated from the case, as both AC wires are above earth potential.

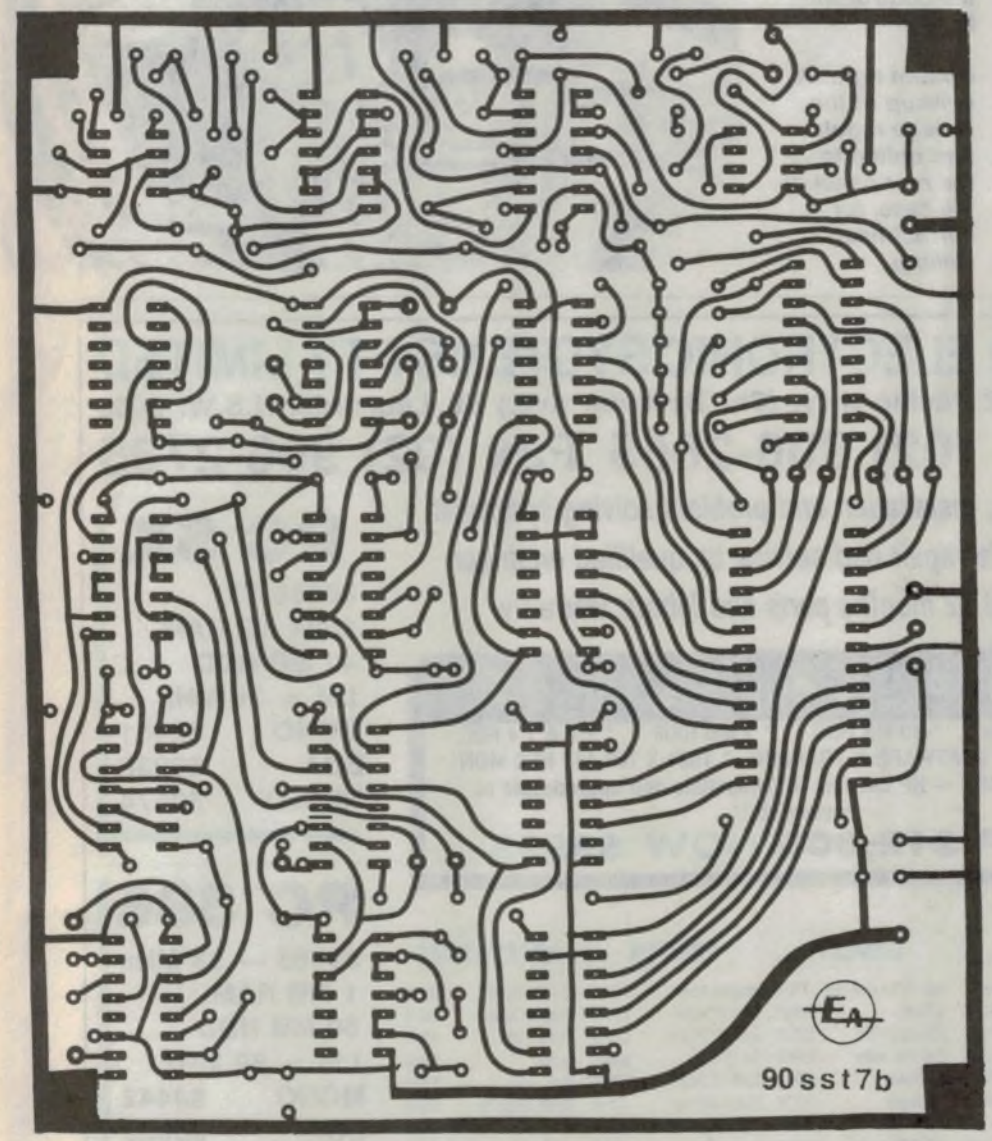
Operating

Now that you have successfully completed your scanconverter, no doubt you are eager to get on the air. If you have looked in on the action before, you will know that the main activity is on the 20m band, on 14.230MHz. Some other likely spot frequencies are 3.670MHz, 7.130MHz, 21.340MHz and 28.680MHz. There may well be some VHF activity in your area as well.

You may need to construct a switch box so that you can switch between your microphone and scanconverter, if you have not done so already.



The PCB pattern for the smaller of the two boards. As usual, it is reproduced actual size for the benefit of those who like to etch their own.



And here's the pattern for the larger board, again actual size. The exact mounting hole size and location is up to you.

The output level should be initially set low and increased by adjusting trimpot VR7, until your transmitter is sending the required power. Remember that this signal is of constant amplitude, so avoid driving your transmitter past its continuous output rating.

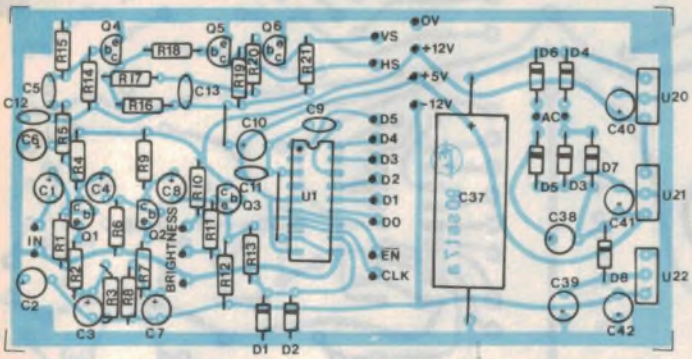
A lot of SSTV stations these days use scanconverters that use an automatic signal at the start of the frame to set the correct speed and mode. This unit does not transmit this code, so that you will need to tell the receiving end your mode so they can manually set their units to receive.

The dual memories are an advantage when on air. For example you could store your callsign in one memory, while using the other memory to snatch pictures of yourself, your shack or your favourite cartoon character and then revert to the first memory to identify yourself.

In the continuous frame mode you could position the camera while you are transmitting a picture, snatch a new picture during the vertical sync pulse, and so have a continuous flow of pictures sent.

It is even possible to transmit colour pictures with this unit, using the frame sequential method. You will need to obtain red, green and blue filters to place in front of the camera. Before you send, arrange with the receiving station the sequence of frames to be sent; this is usually red, green then blue.

Firstly place the red filter in front of the camera and snatch a picture. Using the single frame mode send the picture. Then keeping the camera and subject still, snatch and send the green and blue

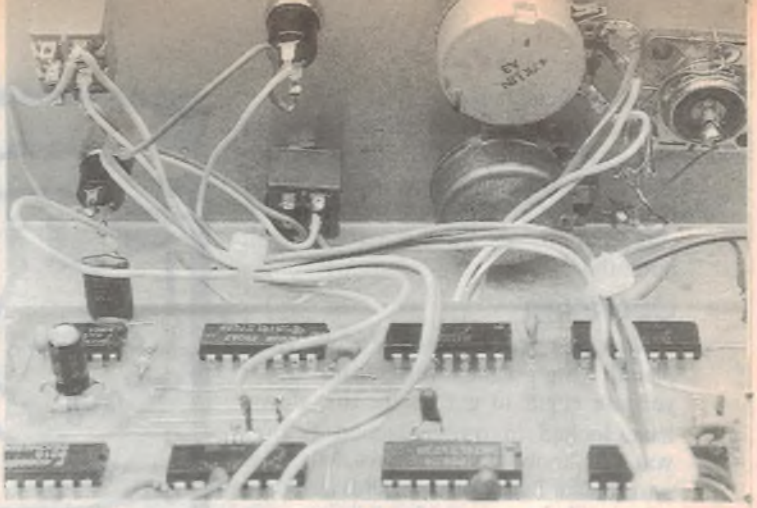


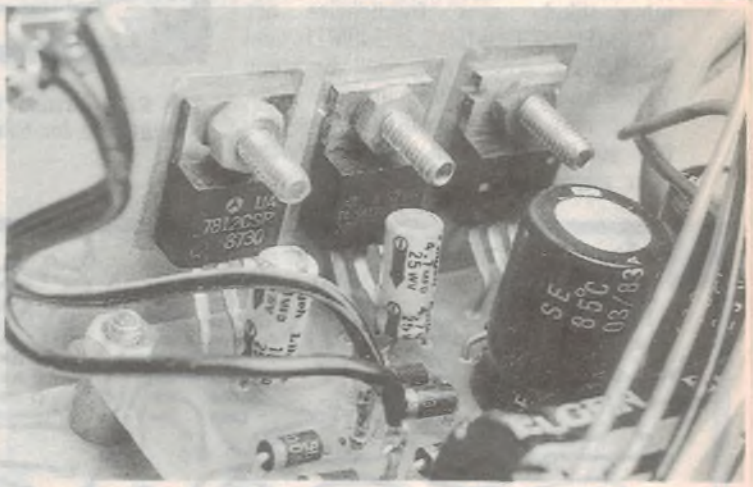
No, we hadn't forgotten – here's the wiring overlay for the smaller PCB board.

pictures the same way. The receiving station will have received the filtered pictures and stored them in his three memories and then combined them to form the colour image.

So that is it. The unit should provide some exciting moments for you. Remember that 14.230MHz is the most active DX frequency, and is also used extensively for VK/ZL contacts. 7.130MHz is also popular in VK2 and VK3 as it provides good short path contacts.

I hope to 'see' you on the air sometime.





Top right: A closeup of the rear of the front panel, showing the control wiring.

Bottom right: A closeup of the voltage regulators bolted to the rear panel of the case, for correct heat-sinking.

Jack O'Donnell
Managing Director

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The actual appearance and finish is to a high standard and attractive.

So what's the problem?

Very simply, the majority of these rack cases are sold by our parent company, Altronic Distributors, to manufacturers and most manufacturers require (and insist on) an anodised finish to match with associated equipment when assembling rack consoles.

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H 0412	Black	$79.95	$49.95	$45.00
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Digital Sine/Square Wave Generator

NEW! NEW! NEW! Another superlative design from the Silicon Chip design team. See Silicon Chip Magazine July '90

The use of modern circuit technology Waveform Synthesis enables this Generator to deliver performance specifications comparable to commercial equipment costing $2000 and more.

This new Digital Sine/Square Wave Generator uses high speed CMOS ICs and a digital filter IC to produce sine and square waves over the frequency range from 0.1Hz to 500Hz. It also features a 4-digit frequency readout and an output level control.

Specifications: Frequency range: 0.1Hz-500kHz in four ranges; 0.1-10Hz; 10-1000Hz; 1-100kHz; & 100-500kHz ● **Output wave forms:** Sine and square ● **Harmonic distortion:** Less than 0.15 from 0.1Hz-50kHz; 0.27% at 80kHz ● **Square wave rise time:** 10ns ● Square wave fall time: 10ns ● **Output level:** Sine wave; variable from 0-1.2V RMS; Square wave; variable from 0.5V p-p ● **Output impedance:** 600Ω nominal ● **Load impedance;** 600Ω to infinity ● **Protection:** Short circuit protected (indefinite) ● **Display accuracy:** +/-2% +1digit

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How many times have you opened up that favourite board game to find that someone has pinched the dice? In that case, why not build this elegant electronic dice which uses just two CMOS ICs? It simulates the roll of a real dice and even turns itself off.

Build this elegant Electronic Dice

LED readout simulates a "dice" — Great fun to build. see Silicon Chip July 90.

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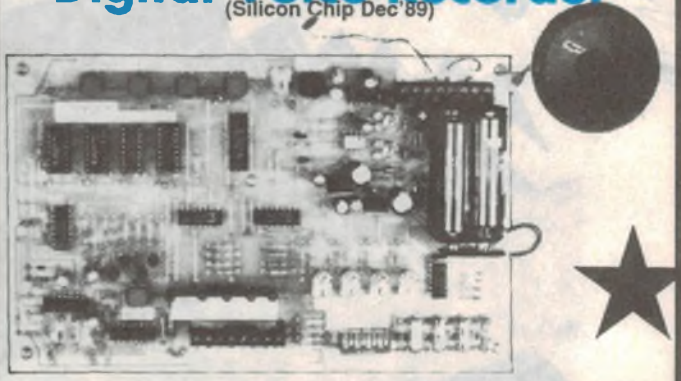
4 separate channels—up to 30 seconds per channel record/playback time.

This Digital Recorder delivers astonishing reproduction of voice and/or music without one single moving part!

Digital Voice Recorder

(Silicon Chip Dec '89)



Here is a digital voice recorder that can store 4 different signals, voice, sound or a music source of up to 30 seconds each or one recording of up to 2 minutes.
There are 4 trigger inputs so that a message can be retrieved when a certain condition occurs.
Battery backup is provided so that the messages are retained when main power is off.
Typical applications include:

● Alarm system messages ● Sales messages for customers put "on hold" ● Experimental telephone answering machine ● Door station announcer ● Talking displays for shops ● Emergency warning message announcement ● Operation instructor for machinery etc. ● Countless other applications where voice or music is required ● $100's cheaper than imported digital recorders

K 9550 Kit complete - PCB Format **$129.00**

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"Silicon Chip" May '90

Superb test equipment!

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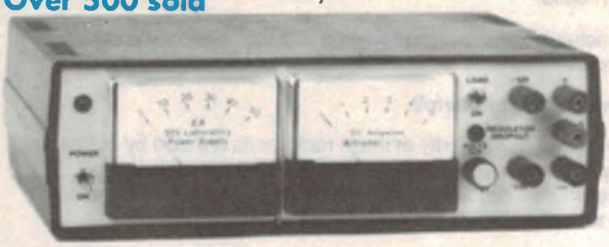
Over 500 sold EA May '85



● 3 to 50Volts at 5Amps
● Single PCB — very easy to build
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For the engineer and hobbyist

K 3301 10 turn O/P control $29.50
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(See EA Aug 85)

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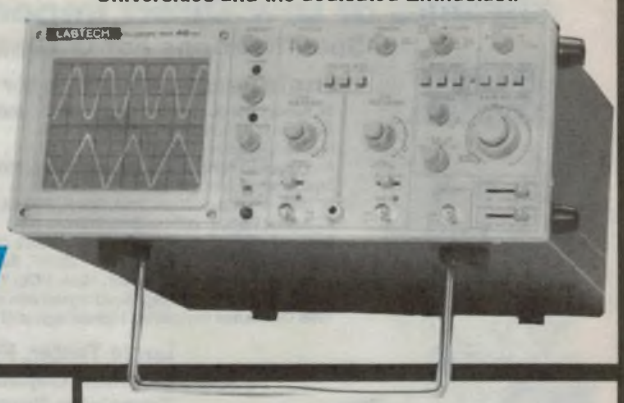
- **Vertical Amplifier (CH1 and CH2 identical)** Operational Modes: CH1, CH2, ADD, DUAL, ALT, CHOP Sensitivity: 5mV - 5V/Div 3% in 1-2-5 steps, 1mV - 1V/Div 5% X5 Mag
- **Horizontal Amplifier** Operating Modes: X-Y operation CH1-X axis, CH-2 Y axis Sensitivity: 5mV - 5V/Div +/- 3% in 1-2-5 steps
Input Impedance: 1MOhm +/- 2%, 25pF +/- 3%
- **Time Base** Sweep Method: AUTO, NORM, SINGLE Magnified Sweep: 10 times +/- 5%, Max 20nS Delay Method: Continuous delay and adjustment
- **Synchronization** A, B, B Triggered, Internal V-MODE, CH1, CH2, LINE, EXT
- **Trigger Coupling:** AC, DC, HF Rej, TV-H (Line), TV-V (Frame) Triggering Sensitivity: INT. DC - 20MHz 1.0 Div, 20MHz - 40MHz 2.0 Div, EXT. DC - 20MHz 150mVp-p, 20MHz - 40MHz 300mVp-p
- **Vertical Amplifier Signal Output:** 50 mV/Div. - 50 Ohm
- **Intensity Modulation Z Axis** Bandwidth: DC - 1MHz, Sensitivity:3Vp-p
- **Probe Calibrator Output :** 1 kHz square wave 1V



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DUAL TRACKING POWER SUPPLY +/- 50V DC AT 1.0AMP

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- Voltage output: 0 to +/-50V or 0 to 100V
- Current output: 1.7A from 0 to 87V (+/-43.5V)
- 1A from 0 to 100V (+/-50V)
- Load regulation, better than 500mV at +/-50V, 1A
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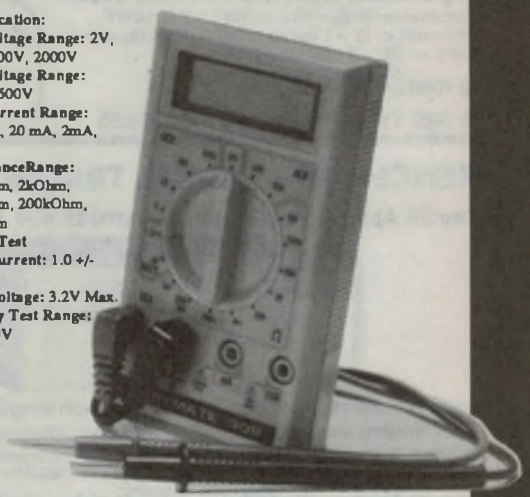
17 Range Digital Multimeter

with Overload Protection

Australia's best value, less than $50

Specification:
DC Voltage Range: 2V, 20V, 200V, 2000V
AC Voltage Range: 200V, 500V
DC Current Range: 200mA, 20 mA, 2mA, 10A
ResistanceRange: 200Ohm, 2kOhm, 20kOhm, 200kOhm, 2MOhm
Diode Test
Test Current: 1.0 +/- 6mA
Test Voltage: 3.2V Max.
Battery Test Range: 1.5V, 9V



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- **Sine Wave Characteristics:** Output voltage: 5V RMS or more at no load Distortion factor (at max output) 0.5% or less Output impedance: 600 Ohms +/-10% Output attenuator: 0 to greater than 50dB continuously variable, ● **External Synchronisation Characteristics** Input impedance: approx. 10kOhms Max. allowable input voltage: 10V RMS ● **Reading Accuracy** 0.01%, +/-1 count ● **Frequency Counter Characteristics** Display: 4 digits, 7mm red LED display Frequency range: 10Hz—1Mhz (square wave) Sensitivity: 25mV RMS Max. input: 150V p-p Input impedance: 1MOhm Square Wave Characteristics (TTL Out) Overshoot: 2% or less (at 1kHz) Rise/fall time: 200n sec or less ● **Power requirements:** 100/120/220V +/-10% 240V +5%, -10%, 48-66Hz

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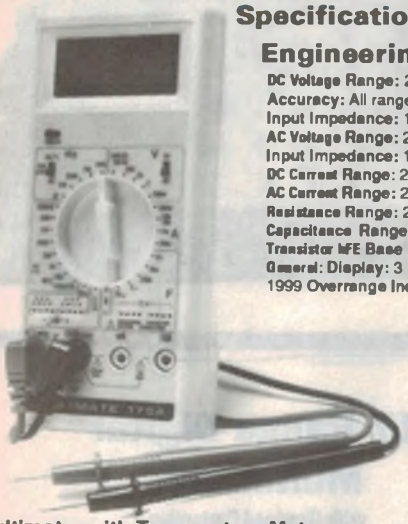
Resistance Range: 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ, 2000MΩ
Capacitance Range: 2000pF, 20nF, 200nF, 2uF, 20uF
Transistor hFE Base DC Current: 10uA, **VCE:** 2.8 +/- 0.4V
General: Display: 3 1/2 digit liquid crystal with maximum reading of 1999 **Overrange Indication:** Highest digit of (1) or (-1) is displayed



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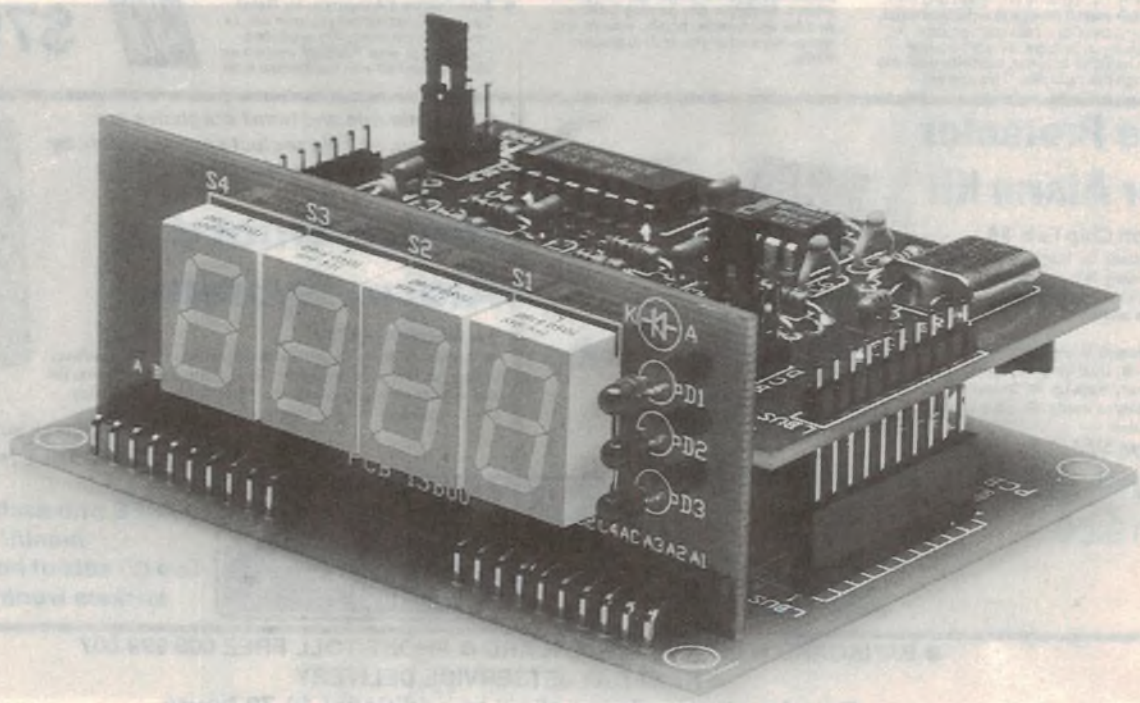
Digital Stopwatch with lap timing



Here's the design for an easy to build four-digit timer counter, which can be used for applications such as a stopwatch, event or racing lap timer. It uses two readily available modules, which can be purchased as kits.

by ANDREW PALMER

Clive Chamberlain and his boffins at Australian Test & Measurement have been at it again. This time they've produced a module which mates with their existing ATM13 four-digit general purpose counter module, to produce a stopwatch/event timer.

In combination the two modules will count time periods up to 9999 seconds, and with resolutions of down to 10 milliseconds. They do this in three ranges: range 'A' reads from 0 to 9999 seconds with a resolution of 1 second, range 'B' from 0 to 999.9 seconds with a resolution of 100ms (1/10th second), and range 'C' from 0 to 99.99 seconds with a resolution of 10ms (1/100th second).

As well as performing normal start/stop single period timing they also provide a 'Lap time' function, allowing you to freeze the reading at a particular instant while the main timer is still counting, to keep track of the overall event time.

The timebase for the counter is derived from a low-cost quartz crystal, giving a timing accuracy of around .001%. This means that the effective accuracy on all ranges is basically the same as the resolution.

These features make the resulting stopwatch/timer suitable for a wide variety of timing applications, from the timing of races and other sporting events to things like checking human reaction times and timing industrial processes.

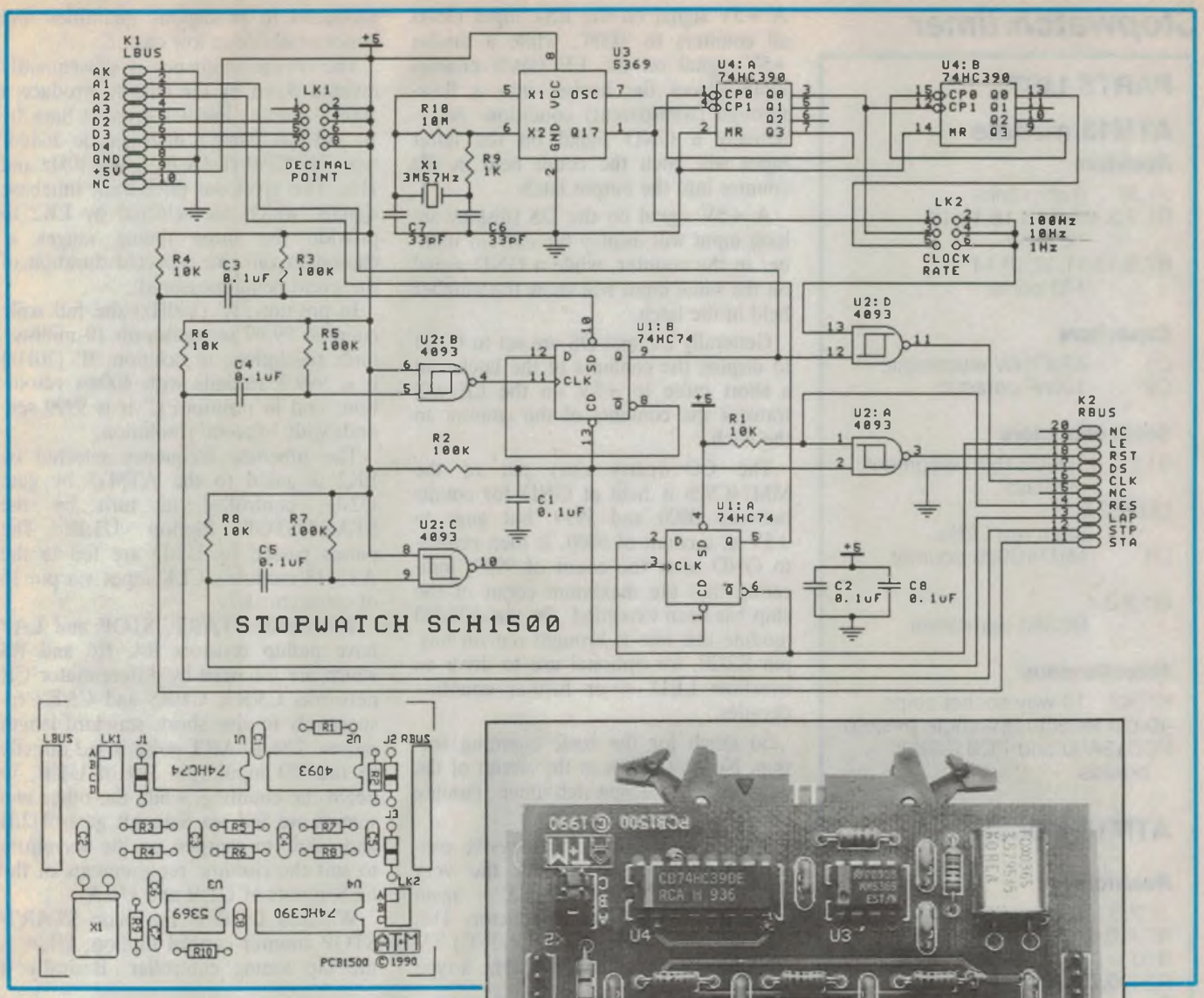
The new module is called the ATM15, and is designed to mount 'piggyback fashion' onto the top of the ATM13 module, plugging into the two SIL sockets provided. This forms a very compact assembly, which will then fit into one of AT&M's neat and rugged little extruded aluminium cases.

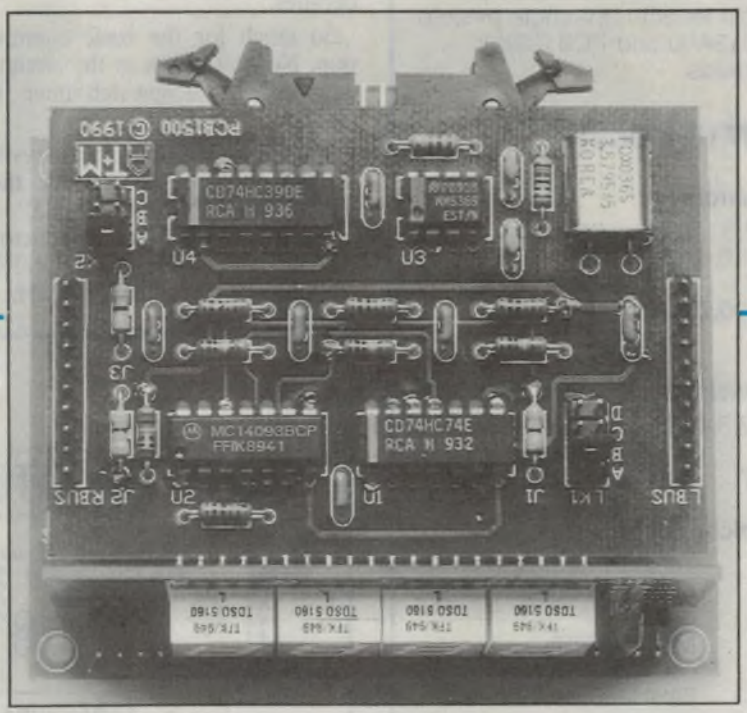
The electrical inputs to the timer can be fed from either CMOS logic signals, or from simple pushbutton switches. The decimal point of the 4-digit display can also be set to correspond to the desired reading range, as desired.

In short, the ATM13/15 combination makes a very flexible and handy little stopwatch/event timer – but one that is at the same time easy to build, and very reasonable in price.

Circuit description

The operation of the basic ATM13 four-digit counter module has been described in *Electronics Australia* before





The circuit schematic for the new stopwatch/lap timing module is shown at top, with the PCB overlay above and a top view of the module at right, plugged into the counter module.

it formed part of the 'Digital Amphometer' project, in the April 1990 issue. However to recapitulate, it's based on the National Semiconductor MM74C926 chip. This is an LSI four decade counter/latch/decoder, with inbuilt display multiplexing for a four digit, 7-segment display (0000-9999).

Multiplexing, you may recall, is where the contents of the four cascaded BCD decade counters and their latches are applied sequentially to a single BCD/7-segment decoder and display driver, with the driver effectively switched to each of the display digits in synchronism. This technique saves both power and components, and results in high efficiency.

In the ATM13 module (Fig.1), the MM74C926 is arranged to drive four high efficiency 7-segment common cathode LED displays, via digit driver transistors Q1-4. The displays have digits 12mm high and produce orange-red 635nm output. This gives a high apparent brightness, which can be improved still further by using a red or orange filter. There is no flicker due to the multiplexing, as the MM74C926's internal multiplexing oscillator sequences the digits at a rate of around 1kHz.

The decimal points for the three most significant digits are brought out separately, to allow hard wiring as desired. In addition the ATM13 has three discrete LEDs (LED1-3) to the right of the main four digit display, for indication of other functions such as range or measuring mode.

The MM74C926 counter is negative-edge triggered, via the CLK input. It can count at rates of up to about 4MHz.

Stopwatch/timer

PARTS LIST

ATM13 module

Resistors

J1,J2 0-ohm links
R1,2,3,4,5,6,15,16,18,19 1k 1/4W
R7,9,10,11,12,13,14 470 ohms

Capacitors

C1 47uF/16V electrolytic
C2 100nF ceramic

Semiconductors

S1,2,3,4 TDSO5160 7-segment displays
LED1,2,3 3mm red LEDs
U1 MM74C926 counter

Q1,2,3,4 BC550 transistors

Miscellaneous

K1,K2 10-way socket strips
40-pin length right-angle pinstrip
PCB13A00 and PCB13B00 boards.

ATM15 module

Resistors

J1,2,3 '0-ohm' links
R1,4,6,8 10k 1/4W
R10 10M 1/4W
R2,3,5,7 100k 1/4W
R9 1k 1/4W

Capacitors

C1,2,3,4,5,8 0.1uF ceramic
C6,7 33pF ceramic

Semiconductors

U1 74HC74 dual flipflop
U2 MC14093 quad NAND gate
U3 MM5369EST oscillator/divider
U4 74HC390 dual decade counter

Miscellaneous

X1 3.579MHz crystal
LK1 4 x 2 pin link block
LK2 3 x 2 pin link block
K1,K2 10-way pinstrips
K3 16-way header (for ATM13)
PCB1500 board,
2 x jumper links

A +5V signal on the RST input clears all counters to '0000', while a similar +5V signal on the LE (latch enable) input places the latches into a flow-through (transparent) condition. Alternatively a GND signal on the latter input will latch the count held in the counter into the output latch.

A +5V signal on the DS (display select) input will display the current number in the counter, while a GND signal on the same input will show the number held in the latch.

Generally LE and DS are set to GND to display the contents of the latch and a short pulse to +5V on the LE will transfer the contents of the counter to the latch.

The CO (carry out) pin of the MM74C926 is held at GND for counts between 0000 and 5999, but goes to +5V at a count of 6000. It then returns to GND after the count of 9999, indicating that the maximum count of the chip has been exceeded. On the ATM13 module this line is brought out on bus-pin K2/20, for optional use to drive an overflow LED – or further counting decades.

So much for the basic counting section. Now let's look at the circuit of the new ATM15 stopwatch/timer module (Fig.2).

The heart of this is a crystal controlled oscillator, based on the very handy MM5369EST chip (U3) – again made by National Semiconductor. This uses an American standard (NTSC) TV colour burst crystal of 3.579MHz, a type produced in prodigious quantities and hence available at low cost.

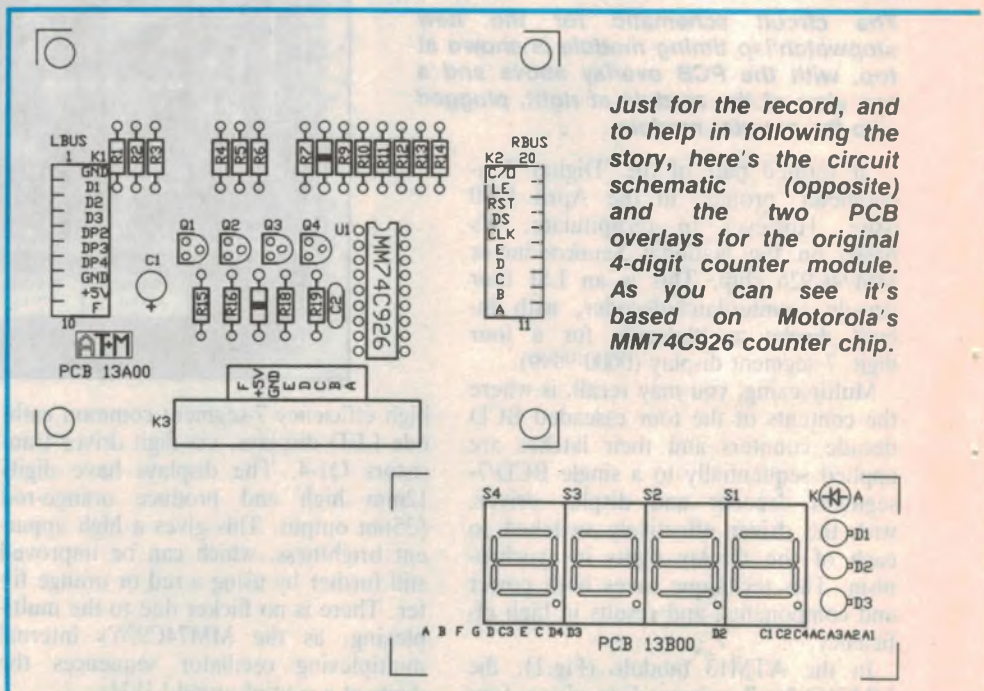
The crystal frequency is subsequently divided down by the chip to produce a 100Hz output. Further division here by 10 and 100, using a dual decade divider type 74HC390 (U4A/B), gives 10Hz and 1Hz. This gives our three basic timebase signals, which are selected by LK2 to provide the three timing ranges – chosen to suit the expected duration of the event being measured.

In position 'A' (100Hz) the full scale count is 99.99 seconds with 10 milliseconds resolution; in position 'B' (10Hz) it is 999.9 seconds with 100ms resolution; and in position 'C' it is 9999 seconds with 1 second resolution.

The timebase frequency selected by LK2 is gated to the ATM13 by gate U2:D, controlled in turn by the START/STOP flipflop U1:B. The pulses passed by U2:D are fed to the ATM13 module's CLK input via pin 16 of connector K2.

The inputs START, STOP and LAP have pullup resistors R4, R6 and R8 which are followed by differentiator CR networks C3/R3, C4/R5 and C5/R7 respectively to give short, standard length pulses. The START pulse is fed directly to the SD input (pin 10) of U1:B, to begin the counting, while the other two signals are fed via Schmidt gates U2:B and U2:C to sharpen up the waveform to suit the risetime requirements of the CLK inputs of U1:B and U1:A.

Whereas U1:B is the main START/STOP counter control flipflop, U1:A is the lap timing controller. Basically it



Just for the record, and to help in following the story, here's the circuit schematic (opposite) and the two PCB overlays for the original 4-digit counter module. As you can see it's based on Motorola's MM74C926 counter chip.

controls the LE input of the MM74C926 on the ATM13 module, via pin 19 of K2. Normally the LE input is held at +5V by the Q-bar output of U1:A (pin 6), but when this flipflop is toggled by a signal from the LAP input, the LE line is taken down to GND and the current MM74C926 count 'frozen' in the latches. A further pulse from the LAP input will toggle U1:A back to its original reset state, restoring the LE line to +5V and re-enabling the MM74C926 latches to their transparent condition so the total count can be seen again.

LK2 selects the appropriate timebase frequency, as already explained, while LK1 allows adjustment of the displayed decimal point.

A power-on reset pulse is generated by R2/C1, and fed to the ATM13 module via U2:A and K2 pin 18 to clear the MM74C926 counters to '0000'. The same power-on reset pulse is fed to flipflops U1:A and U1:B, to make sure they are initialised.

A return to the reset state may be produced at any time by grounding pin 14 of K2. This is brought out on the ATM13 module to pins 'D' of the 16-pin rear connector K3, which is for external connections.

In the same way the START input is brought out to K3 pins 'A', the STOP input to pins 'B', and the LAP input to pins 'C'. The only other connections to K3 are the '+5V' and 'GND' power inputs.

The Q outputs of U1:B and U1:A are connected to LED1 and LED2 respectively on the ATM13 module, via K1 pins 2 and 3. This results in LED1 displaying the timing status, while LED2 illuminates when the LAP function is enabled.

Construction

The ATM13 counter module consists of two PCBs, the counter/driver 13A00 and the display board 13B00, which are joined together by two 10-way right angle pinstrips for electrical connection and mechanical rigidity. The connections between the ATM13 and the ATM15 module, which is a single board, are made via two more 10-way pin strips and sockets soldered either side of the PCB.

It's probably best to begin assembly with the ATM13 boards. Load the smaller PCB first, by inserting the displays with the decimal points nearest the two rows of connector holes. Solder neatly, avoiding solder bridges and dry joints. Next the LEDs can be loaded, with the longer anode leads to the right hand side of the PCB.

The 40-way right angle pinstrip supplied must be snapped into four strips of 10 pins, two of which are loaded with their 'short ends with insulator' into the front of the small PCB, with their longer ends pointing downward. Then solder the pins to the rear copper, making sure the strips are pushed down with their insulator strips against the front surface of the PCB.

The main 13A00 PCB can now be loaded, using the overlay to locate the resistors and two '0-ohm' jumpers – indicated by a single dark central band. These are all then soldered. Next the IC, followed by the transistors, the two socket strips and the capacitors – making sure you fit C1 with the correct polarity.

Finally fit the 16-way connector K3 to the rear of the board, securing it with a couple of 6BA screws and nuts before soldering the pins. Note that each pair of pins are connected in parallel, to improve current-carrying capacity.

The two PCBs of the ATM13 can now be joined by pressing the 10-way display PCB connectors down into the counter PCB. Line up the two PCBs carefully at right angles, and solder into place.

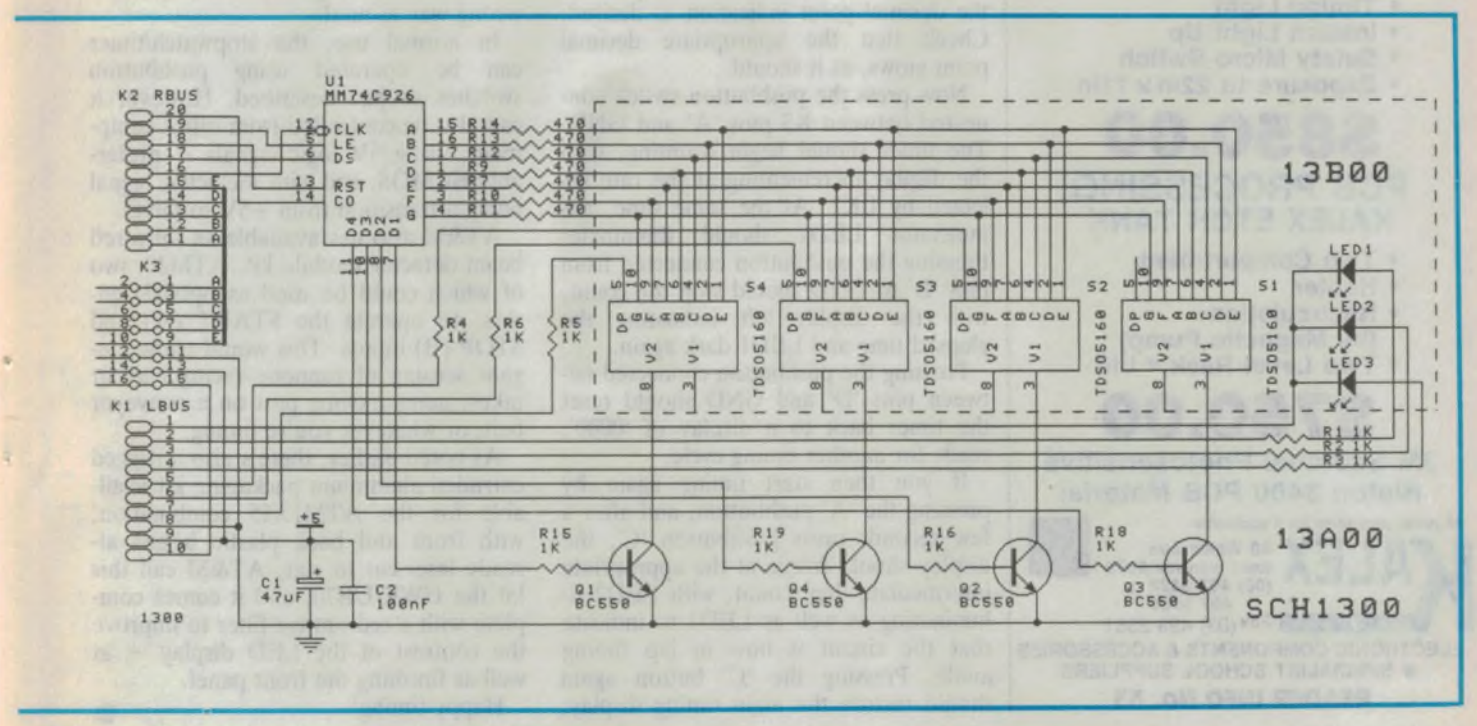
You can now turn to assembling the ATM15 module. As before it is good practice to load and solder the components in order of height, so start with the resistors followed by the capacitors, ICs, and crystal.

Hold the crystal leads with a pair of long nosed pliers before bending the leads, to avoid fracturing the glass seal. They should be bent at 90°, about 4mm from the seal. The crystal can be secured to the PCB with a bit of double-sided tape, before soldering the leads.

At this stage prune all leads on the bottom of the PCB to be level with the solder bumps.

The final step is to add the LK1 and LK2 link pin connectors, and the 10-way pin strip connectors K1 (L-bus) and K2 (R-bus). These are all pushed through from the top of the PCB, and soldered on the underside.

Note that the ATM15 board is dou-



ble-sided, but for economy doesn't have plated-through holes. It's therefore necessary to solder a number of component leads and IC pins to the top tracks, as well as to the underside. The leads and pins to be soldered on the top should be fairly clear from the clear areas in the solder resist layer, so that you've probably soldered them already. But it's a good idea to check at this stage, just to make sure; the circuit won't work if these joints aren't soldered.

Testing

To try things out, plug the completed ATM15 board into the top of the ATM13. It will only plug in one way around, with the crystal towards the rear.

Now connect the '+5V' and 'GND' pin pairs on the ATM13's rear connector K3 to a suitable 5V DC power supply, and also connect four normally-open pushbutton switches from pin pairs A, B, C, and D respectively, to the GND pins. The easiest way to make all of these connections is via a 16-way ID-type socket, and a suitable length of ribbon cable.

Turn on the power, checking that the main display shows '0000' and that none of the three annunciator LEDs (LED1-3) are illuminated. The display should also remain static, at this stage.

If you have a 'scope or frequency counter, check for 100Hz clock pulses at pin 1 of U3, then 10Hz pulses at pins 3 and 12 of U4, and 1Hz pulses at pin 13 of U4.

Position the jumper for link LK2 to suit the expected duration of an event of interest, and that for LK1 to position the decimal point indication as desired. Check that the appropriate decimal point glows, as it should.

Now press the pushbutton switch connected between K3 pins 'A' and GND. The timer should begin counting, with the display incrementing at the rate selected by LK2. At the same time, annunciator LED1 should illuminate. Pressing the pushbutton connected from pins 'B' to GND should stop the count, with the display left indicating the elapsed time and LED1 dark again.

Pressing the pushbutton connected between pins 'D' and GND should reset the timer back to a display of '0000', ready for another timing cycle.

If you then start timing again by pressing the 'A' pushbutton, and after a few seconds press pushbutton 'C', the display should freeze at the appropriate intermediate 'lap' count, with LED2 illuminating as well as LED1 to indicate that the circuit is now in lap timing mode. Pressing the 'C' button again should restore the main timing display, and cause LED2 to turn off. As before button 'B' should stop the timer and turn LED1 off again, with the final timing count displayed.

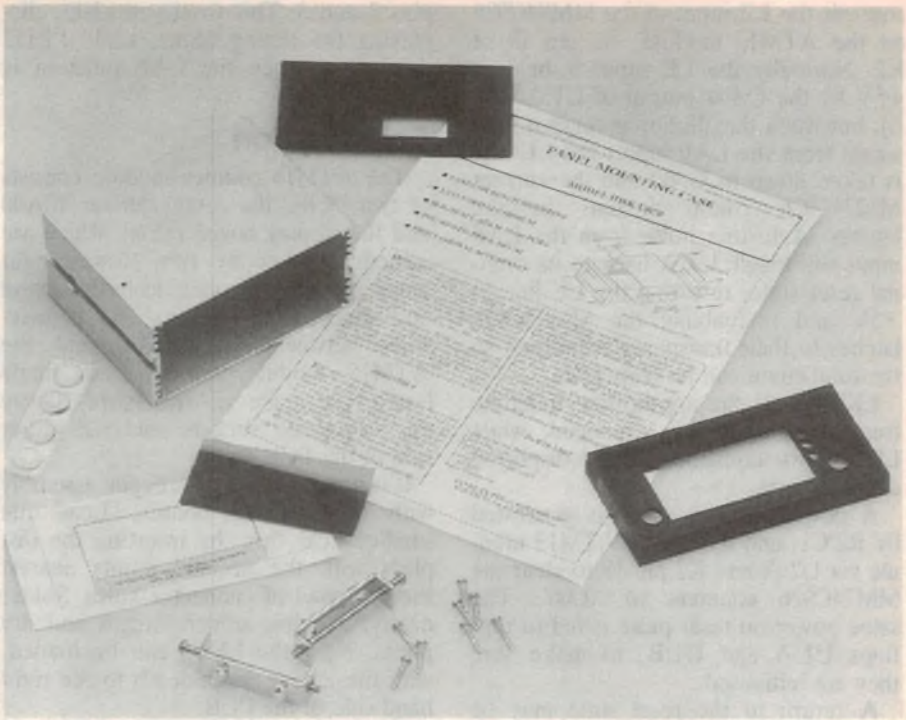
If everything behaves as just described, your stopwatch/timer is operating as it should. If not, the odds are that you've made a wiring error – perhaps not soldering one of those component leads on the top of the ATM15 board, or installing one of the IC's the wrong way around.

In normal use, the stopwatch/timer can be operated using pushbutton switches as just described. However it can also be controlled from other equipment, using 5V logic signals – preferably HCMOS, and with the active signal being a transition from +5V to GND.

AT&M also has available an infra-red beam detector module kit, ATM20, two of which could be used as optical sensors, to operate the START (A) and STOP (B) inputs. This would allow elegant sensing of runners, racing cars or bikes, items moving past on a conveyor belt, or whatever you're timing.

As noted earlier, there's also a rugged extruded aluminium packaging kit available for the ATM13/15 combination, with front and back plastic bezels already laser-cut to suit. AT&M call this kit the HWK/UB70, and it comes complete with a red-orange filter to improve the contrast of the LED display – as well as finishing the front panel.

Happy timing!



AT&M also makes available this very neat little packaging kit for the timer, based on a section of rugged aluminium extrusion and two laser-cut plastic plastic end bezels.

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- 128K cache memory
- 1.2M FDD
- 40M 28mS HDD
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- 1 Parallel port
- 1 Games port
- On Board Real Time Clock
- 16 Bit 256K VGA card
- VGA monitor
- 101 Keyboard
- Full size tower case
- 220W power supply
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READER INFO No. 34

Shutter timer

Continued from page 25

marks. The lens cannot 'see' the full distance around the circumference, so what one is measuring is actually the length of a chord. Mark this chord on a full-size drawing of the disc, then measure the angle between the centre and the points of the chord and proceed as for disc A.

For slower shutter speeds, I geared down the electric motor to run at 375rpm. At these speeds, 18° represents 1/125 sec. and 37° corresponds to 1/60 sec. With these discs, there is a definite advantage in keeping the angles reasonably small because, in doing so, any troublesome distortion is minimised.

The procedures described measure total exposure time, the same as an electronic instrument. Cameras used were 35mm, 6 x 6 and 6 x 0. Many were borrowed. I took three cameras to be electronically tested and found close agreement with my own results.

The width of the white lines is a consideration. For disc A, deduct 0.7° from angle measurements taken at the circumference and for disc B, 0.6°.

An electronic timer is a very expensive instrument. My expenditure on the apparatus described here was less than $45.

Ultimate speaker leads

Continued from page 51

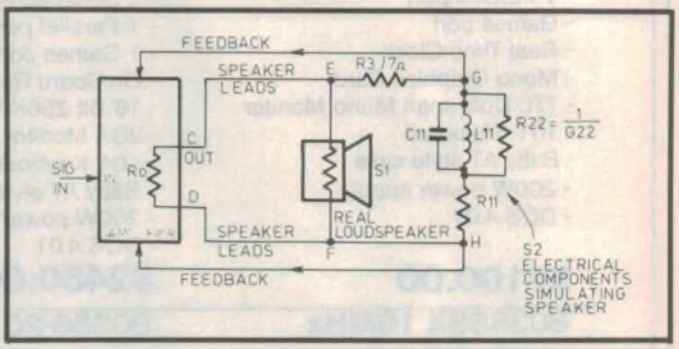


Fig.5: The author's proposed system for achieving NEGATIVE effective output resistance from the amplifier.

having ordinary positive output resistance.

This can only be explained by saying that, as seen by the speaker feed points E-F, the system output resistance Ro is in fact negative!

Would you believe that Ro could now be –7 ohms? That mild negative value would make the series sum (Ro + R1) equal to (–7 +8) = 1 ohm, leading to eight times heavier damping factor than before.

Postscript

Do you believe it? Has your incorrigible author been honest, fair-dinkum and entirely above board?

Peccavimus et benedicte! You be the judge. You might even like to try building up the scheme shown in Fig.5, to try it out for youself.

But now, please, let's not hear any more gumph about the oxygen, arsenic and sulphur impurities in copper! Nor will I tolerate bleatings bemoaning the conductivity loss due to crystalline dislocations in copper, due to bending or dropping wires and cables...

If you must worry about such miniscule reductions in copper conductivity, just use bigger cross section conductors!

Perhaps next time you'll want to do it digitally and use fibre optic speaker cables. Happy listening!

MULTIMETERS

EDM1133 Digital Multimeter
- 8 Autoranging Functions Vdc, Vac, Adc, Aac, Ohms, Diode, Continuity etc.
- Analog Bar Graph
- Range Hold
- 3 3/4digits

EDM1133 $172.60 ($148.80)

EDM1155 Digital Multimeter
- 12 Functions including capacitance to 40µF
- Peak Hold, Data Hold
- Analog Bar Graph
- 3 3/4digits

EDM1155 $203.15 ($175.10)

Fluke 80 Series... Top of the line!
- 4 3/4 digit 4000 count resolution
- Digital Display updates 4 times/s
- 87 has analog pointer, 83/85 have bargraph with zoom mode.
- 0.5Hz to 200kHz Counter with duty cycle from 0.1% to 99.9%
- 10pF to 5µF Capacitance range
- Input alert warning
- 87 is a true rms 1ms Peak Min Max hold with backlit display
- Touch Hold and Relative modes

83 $478.80 ($399.00)
85 $576.00 ($480.00)
87 $696.00 ($580.00)

Also...
23 $393.60 ($328.00)
73 $180.00 ($150.00)
75 $288.00 ($240.00)

EDM1177 Digital Multimeter
- 14 Functions including frequency to 400kHz, capacitance to 40µF etc
- Peak Hold, Data Hold, Range Hold
- Analog Bar Graph
- 3 3/4digits

EDM1177 $248.80 ($214.50)

400A AC/DC Clamp Meter
- 3 1/2 digit LCD
- 8 functions including temperature (K type input)
- Peak hold, Data hold
- 400A, 100Vdc/750Aac

DCT310 $183.70 ($159.20)

1000A Clamp Meter
- Huge 52mm jaws
- 750Vac range
- 10 to 1000Aac
- Analog Movement with stop

ST1000 $118.50 ($102.70)

300A Clamp Meter
- 6 to 300Aac ranges
- 0 to 600Vac
- Fuse protection
- Analog movement with stop

ST300 $77.40 ($67.00)

400A Clamp Meter
- 20A to 400A ac
- 750Vac
- Peak Hold

DCT300 $126.95 ($109.50)

3486A Autoranging DMM
- 3 1/2 digit
- 8 functions
- Data Hold
- Auto power off

3486A $91.10 ($79.34)

3487A Autoranging DMM
- 3 3/4 digit
- 11 functions
- Analog Bar graph
- 40kHz frequency counter
- Relative measurements
- Max/Min store
- Data Hold

3487A $144.00 ($125.75)

L/C/R Meter
- 3 1/2 digit
- Dissipation factors for L and C
- 200pF to 2000µF
- 200µH to 200H
- 200Ω to 20MΩ

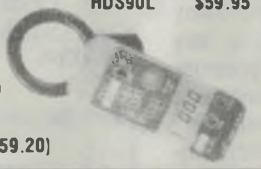
ELC130 $251.15 ($217.70)

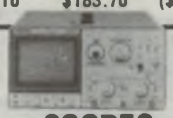
Analog Multimeter
- dB, L, C and R ranges
- 10A dc
- 2kΩ/V sensitivity
- 1000Vac/dc

ST350 $31.20 ($27.00)

Probe Type Multimeter
- 3 1/2 digit 14mm LCD
- Logic Tester

HDS90L $59.95 ($53.85)





SCOPES

60MHz 3 Channel Scope
- 5mV/div dc to 60MHz
- 5ns/div to 0.5s/div A and B

COS5060B $1859.00 ($1593.90)

40MHz 2 Channel Scope
- 5mV/div dc to 40MHz
- 20ns/div to 0.5s/div Main
- 0.2us to 0.5ms/div Delayed

COS5041 $1372.50 ($1176.50)

20MHz 2 Channel Scope
- 5mV/div dc to 20MHz
- 20ns/div to 0.5s/div

COS5020 $882.90 ($756.80)

20MHz Readout Scope
- Cursor measurements
- 5mV/div dc to 20MHz
- 20ns to 0.5s/div

GOS625 $806.40 ($691.15)

10MHz Low Cost Scope
- Compact, single channel
- 5mV/div dc to 10MHz
- 10ms/div to 0.1µs/div

GOS3310 $496.65 ($425.69)

POWER SUPPLIES

GPQ3020 DC Power Supply
- 2 by 30V/2A variable outputs
- Fixed 5V/3A and 5V/1A outputs

GPQ3020 $725.90 ($625.80)

GPQ3030 DC Power Supply
- 2 by 30V/3A variable outputs
- Fixed 5V/3A and 5V/1A outputs

GPQ3030 $743.40 ($640.90)

GPR3030 DC Power Supply
- Single 30V/3A output
- Fine/Coarse control

GPR3030 $280.50 ($241.85)

240V Variable Transformer
- 7A rating at 0 to 270Vac
- 4mm captive terminals

HSN0203 $187.30 ($162.30)

240V Variable Transformer
- 5A rating at 0 to 250Vac
- Sturdy steel case

HSN0103 $159.60 ($138.30)

Isolation Transformer
- Fast acting 6A circuit breaker
- Separate V and I meters
- 3A ac isolated output

MA4803 $766.50 ($664.30)

Digital Thermometer
- 3 1/2 digit pocket size
- -50°C to +750°C
- Fast response bead sensor

TM902C $117.50 ($102.80)

Lux Meter
- 3 ranges 2000lux to 50000lux
- ±5% accuracy
- Detachable sensor

LX101 $103.50 ($89.70)

RF & AUDIO

2MHz Function Generator
- Built-in counter and sweep generator
- AM and FM modulation

GFG8019G $619.60 ($536.95)

2MHz Function Generator
- 4digit LED frequency readout

GFG8020G $446.85 ($387.25)

120MHz Frequency Counter
- 20mV sensitivity to 100MHz
- 8 digit display

GFC8010G $300.10 ($261.40)

550MHz Frequency Counter
- similar to GFC8010G

GFC8055G $439.90 ($383.15)

EPROM PROGRAMMING

Husky EPROM Programmer
- Professional PC based programmer
- Simultaneously programs up to 4x32pin, 4EE/EPROMs, 4 PALs
- 1MB program in under 3minutes

Husky $1092.00 ($936.00)

Shooter EPROM Programmer
- Standalone with LCD display
- 11MHz cpu
- Programs CMOS 2716 to 27512
- 512k RAM buffer
- 32pin ZIF socket
- RS232 port etc

Shooter $962.50 ($825.00)

LER123 EPROM Eraser
- 34x28pin capacity
- Double element
- Variable timer

LER123 $263.25 ($226.95)

QUV-T8T EPROM Eraser
- 5"x8" slide out tray
- Timer
- 15 EPROM capacity
- 20-30mins

QUV-T8T $261.55 ($224.20)

LER121 EPROM Eraser
- 9x24pin capacity
- 5000µW/sq cm element

LER121 $105.30 ($90.80)

Logic Probe
- TTL, CMOS, 24V compatible
- 17MHz max frequency
- 30ns detection
- Hi, Lo, Pulse LEDs

E301 $30.05 ($26.15)

Logic Pulser
- 0.5 to 400pps
- 10µs width at 100mA load
- Sync input

ELP810 $39.95 ($34.60)

1.3GHz Frequency Counter
- 5Hz to 1.3GHz
- Switchable LPF and Attenuator
- 8 digit LED display
- 20mV sensitivity to 100MHz

EFC2203 $773.90 ($674.00)

RF Generator
- 100kHz to 150MHz
- 100mV output to 35MHz
- AM modulation, Counter output

GRG450 $264.00 ($228.80)

Audio Generator
- 10Hz to 1MHz in 5 ranges
- 20Vpk-pk output, <0.1% dtort

GAG808B $301.80 ($262.85)

Millivolt Meter
- 1mV to 300Vac rms
- 5Hz to 1MHz

GVT416 $266.00 ($231.70)

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229 Burns Bay Road, (Corner Beatrice St.)
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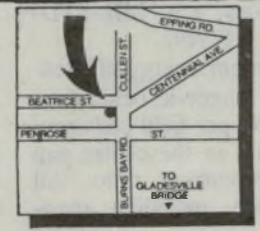


SUPPORT WORLD WILDLIFE FUND AUSTRALIA

NEW PRODUCTS

20MHz mini portable scope

The V209 20MHz mini portable oscilloscope by Hitachi is capable of operating from the mains supply of 12V DC with 2 hours of continuous use from the battery.

It is lightweight at only 5kg, and small - 110 x 215 x 350mm, but with its compact design, performance doesn't suffer.

It has an easy to read 3.5" high luminescent high resolution CRT with internal graticule, 1mV/div vertical sensitivity and 0.5us/div with x10 magnifier to 50ns/div timebase, 3% accuracy and a risetime of 17.5ns.

The scope employs a TV sync separator with one touch synchronisation of horizontal and vertical signals. It has automatic focus control and trace rotation. The X-Y operation allows phase measurement DC-200kHz (–3dB) with 3° phase up to 100kHz.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.

Shakers for product testing

The model B395/D395 shaker is a low-profile, wide-band, air cooled, electrodynamic shaker specifically designed for high-reliability vertical testing in conjunction with CERT and products-screening applications, e.g. MIL-STD-781C and NAVMAT P-9492.

To achieve maximum energy efficiency, a double-sided magnetic field structure is used. Two copper field coils provide maximum gauss in the centre gap for a high force-to-current ratio. All electrical connections, including armature and field coils, air-flow and over-travel interlocks, are made via locking connectors at a junction box conveniently located at the top of the shaker body.

The body suspension employs an efficient system of pneumatic isolators, located above the centre of gravity at the four corners of the shaker body.

For further information contact M.B. & K.J. Davidson, 17 Roberna Street, Moorabbin 3189 or phone (03) 555 7277.

Multi-function pressure monitor

The new Australian made PM2 panel mount and TP2 weather proof series pressure monitors from AIC have many features, accepting an input from any conventional strain gauge pressure transducer. The units can function as a pressure display, pressure controller, signal conditioner, pressure alarm, liquid level display, signal lineariser, computer interface, transmitter and batch controller.

A feature of the PM2 is the ability to sense the voltage at the transducer and compensate for the line voltage drop. The excitation voltage and input sensitivity are link selectable.

The instrument has many keypad programmable functions including single or two point calibration, set point relays (can be set to various combinations of high and low, n/o, n/c, hysteresis, delay on/off, latching and internal alarm beeper, etc), decimal point position, extra display zero digit and digital filter (for noisy signals).

For further information contact Amalgamated Instruments, 7/21 Tepko Road, Terrey Hills 2084 or phone (02) 450 1744.

Universal input power supply

Power General has released a new range of 65 watt switching power supplies that will operate from 85 - 265V AC or 100 - 370V DC.

The auxiliary outputs come in a combination of triple or quad configurations with zero % minimum load required on all auxiliary outputs. The supplies are overcurrent, overvoltage and short circuit protected.

Six models provide outputs of +5V DC along with combinations of –5, 5(Iso), +12 (Iso), –12 and +24V DC. Efficiency is 65%, holdup time 16ms and isolation is 5300V DC. Soft start, overvoltage protection on +5V DC, VDE/FCC class B onboard EMI filter and current limiting are standard features on all models.

The transient load capability of the +12 and +24V DC outputs make up the FLU3-65 and FLU4-65 series suitable for applications requiring pulsed load capability, for electromechanical devices such as disk drives and tape back-up systems.

For further information contact Priority Electronics at 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266.

High performance 6.5 digit DMM

The Prema 6000 is a high performance 6.5 digital multimeter with Gohm input resistance up to 2V and 100nV resolution.

It offers seven functions, including true RMS voltage and current measurements as well as 2-wire and 4-wire resistance and 4-wire temperature measurements. Temperature is measured using PT-100 type thermocouples with 0.01°C resolution (range –200°C to +850°C).

There is a choice of three integration times – 100ms, 1s and 10s. In addition, an optional in-built 4 pole, 10 channel scanner is available for the model 6000. This is activated either from the front panel of the model 6000 or remotely via the IEEE 488 bus, and allows the user to scan up to 10 different measuring points.

High stability amplifiers and a precision analog to digital converter permits uninterrupted averaging without disturbing breaks for continual automatic zero correction, even with 100nV resolution, which is achieved after only 1s integration time.

For further information, contact Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

Membrane switch systems

New Scotch membrane switch systems use multiple layers of specialised adhesives to permanently bond, insulate and separate circuit components and are extremely resilient. The adhesive is designed with very high shear strength, so that it withstands the constant stress of activation as well as harsh environments.

Every time a key is pressed, the flexible overlay of a membrane switch 'pulls' on the underlying adhesive while making contact with the surface. The adhesive bond in Scotch membrane switch systems returns to place after each 'pull', and does not gradually seep into the circuit, a problem which often causes other circuits to fail.

The switches resist moisture, extreme temperatures, ultraviolet radiation, and solvents such as detergents, chemicals, and household cleaners. Most importantly, the adhesive in Scotch membrane switches retains strong cohesion over time, preventing components from slipping as well as helping the product to perform reliably year after year.

For further information contact 3M Australia, 950 Pacific Highway, Pymble or phone (02) 498 9333.

Surface mount dry reed switch

The Clare Dyad is a hermetically sealed dry reed switch. The laser sealing process is performed in a nitrogen environment to enhance the life of the switch. The contact area is characterised by bifurcated blades that reduce the bounce on operate. The flat blades of the switch are made from a nickel-iron alloy and exhibit high magnetic permeability.

The width of the blades and the ease of formation make the Dyad well suited for surface mounting. The Dyad has a glass length of 15.24mm and 2.54 x 1.14mm width. The overall length to the extremities of the terminals is 19.56mm.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 748 4066.

Mini solder bath

OK Industries has announced the release of the model MS-6060 mini solder bath.

The MS-6060 is a simple, compact and easy to operate mini solder bath designed ideally for tin processing applications. Its 300W heater enables rapid heating of the 1.2Kg of solder carried which, coupled with the K type thermocouple feedback loop, assures accurate and stable control of the molten solder temperature over the range of 200°C to 450°C.

This compact benchtop bath saves space, while the heavy duty solder bath construction ensures long life with high heat resistance.

For further information contact Electronic Development Sales, 2a/11 Orion Road, Lane Cove 2066 or phone (02) 418-6999.

Replacement video heads

Sydney-based audio components specialist Wagner Electronics has released the Dai-Ichi brand of VCR heads. The Dai-Ichi brand is new in Australia, but the Japanese factory is one of the main manufacturers of video heads in the world and has earned a repution for quality. They are suppliers to many of the major VCR manufacturers.

Wagner Electronics intends to make the Dai-Ichi brand available as a low-cost replacement part for repairs to VCRs. Dai-Ichi substitute video heads are available for VCRs made by JVC, Sharp, National, Akai, Sony, Toshiba and Hitachi.

Further information from Wagner Electronics, 305 Liverpool Road, Ashfield 2131 or phone (02) 798 9233.

Fast NiCad charger

Eveready Australia has developed a one hour Fastcharge nickel-cadmium battery system which reduces battery recharging time from 14 hours to one hour.

The system consists of a one hour charger and power pack, plus AA size rechargeable batteries in blister packs of two or four. The batteries are designed to take the high current associated with one hour charging.

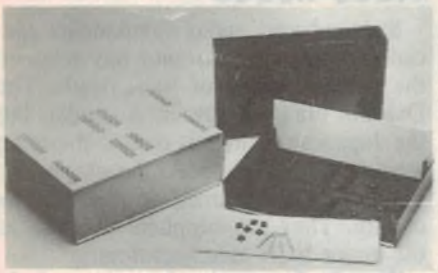
The charger is matched to the characteristics of the batteries so that one to four batteries can be fully charged within one hour, safely and without damage.

A special detection system allows the charger to adjust to a Fastcharge battery and charge it in one hour. Similarly, it will detect ordinary NiCads and charge them in 14 hours. An interlocking cover prevents the unit from operating unless the cover is properly closed.

The design of the charger will not permit the accidental reversal of batteries – a common cause of the destruction and potential explosion of batteries in other units.

For further information contact Eveready Australia, 30-40 Harcourt Parade, Rosebery 2018 or phone (02) 667 0444.

NEW PRODUCTS



'Super large' instrument cases

Altronics has released a new 'super large' range of Australian-made instrument cases, moulded in tough shock-resistant ABS plastic. Similar in basic design to the company's very popular H-0480/1 and H-0482/3 cases, the new H-0490/1/2 cases measure 355 x 250 x 122mm – large enough to house higher power inverters, amplifiers, power supplies, microcomputer systems and instruments.

Like the smaller cases, the new cases employ a four-part construction, with moulded upper and lower sections and removeable front and rear panels. An array of internal mounting pillars are provided to support transformers and other heavy components, as well as for PCB mounting, etc. Both upper and lower case sections are provided with many ventilation slots for air-flow cooling.

The new cases are available in three colours: grey (H-0490), black (H-0491) and blue (H-0492). The ABS front and rear panels are designed for easy punching, and with a smooth finish for silk screening.

Retail price of the new cases is $39.95, but Altronics can also offer an attractive quantity discount price for OEMs.

Further details from Altronic Distributors, 174 Roe Street, Perth WA 6000 or phone (09) 328 1599.

MIDI controllers, interfaces

The Fadermaster MIDI command controller features include eight programmable MIDI faders; scan speed, range, grouping and MIDI channel are selectable per fader; lithium battery backed RAM memory; 10 user programs; 30 factory presets, MIDI in and out with programmable Echo through; bright readable LED display.

The Nexus Plus two input by eight output MIDI patch bay features selectable merging, transposition and zoning (four overlapping zones can be programmed), plus channel filtering and auto thinning of MIDI controller data.

There's also a panic button, battery backed memory and toggle switches to select MIDI input A, B or merged inputs.

The MacNexus MIDI interface for Macintosh features on Macintosh serial port connector, one MIDI input and three MIDI outputs and activity LED's. The serial port connector plus into Mac's printer or modem port.

Synapse is a fully programmable 16 input by 20 output MIDI switcher and processor. It features three independent programmable MIDI processors, each with channel filtering, channel bumping, data filtering to selectively remove notes, controllers, pitch bend, program change, after touch, system exclusive and system common message.

For further information contact Tradepower International, 29A Glenvale Crescent, Mulgrave 3170 or phone (03) 560 9111.

Automated audio measurements

The Tektronix VM700A option 40 audio measurement set can totally characterise an audio path in under 35 seconds with no interruption of video measurements in progress. The Tektronix ASG-100 audio signal generator produces the tone sequences used by option 40 for measuring to CCITT 0.33, ANSI T1.502-1988 or EIA/TIA-250-C standards.

Automated measurement results are presented in an easy to read tabular format that is identical to the VM700A's familiar auto mode video measurements. All the convenience of remote logging, timed reports and user set alarm limits are retained for audio measurements as well.

Option 40 utilises an FFT (fast fourier transform) to provide a real-time dual-channel spectral display of audio frequencies. This display includes a read-out for signal-to-noise ratio. And with the aid of a cursor, the signal level at a specific frequency can be measured.

The option 40's audio analyser mode allows manual measurements of frequency response, THD+N, phase and level difference between channels and crosstalk for both channels.

For further information contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or phone (02) 888 7066.

'Obsolete' personal computers

Continued from page 60

as things like logs and square roots. So they have all kinds of possibilities for electronic calculations (See my article in *EA* for November, 1989).

You can pay heaps of money for a computer spreadsheet, and like word processors they can become very bloated memory hogs. But, as usual, there is an alternative: Supercalc. Again it comes in both CP/M and IBM versions. I use Version 2 with CP/M and Version 3 with IBM. Supercalc is now into Version 5 and is being actively marketed for the PC. And yes, there are Shareware versions such as PC-Calc.

(Editor's Note: Sorry to interrupt, Tom, but there's also Microsoft's original spreadsheet, Multiplan Version 1. It too was sold in both CP/M and MS-DOS versions, again virtually identical and quite powerful enough for most purposes. I still process all of EA's contributions payments, and print cost estimates on Multiplan Version 2, which is only slightly fancier...)

Circuit board design is the one process that demands graphics, so CP/M is out, unfortunately. But, despite what you may be told by the computer professionals, you don't need a really flashy PC to do PCB design. The humble 'colour graphics adapter' format is fine, even without a colour monitor. I've been using a package called 'Protel Easytrax' (reviewed in *EA* December, 1989) with a simple amber-screen video monitor hooked up to the CGA connection, and it works fine.

Where are they?

Look at the ads! IBM computers come in two basic types, XT and AT. AT stands for 'advanced technology' and you're expected to pay big bucks for it. But the XT is no longer trendy, so you can expect to find brand new ones for under $1000. Used XT systems, tossed aside for the more desirable AT's, can be picked up, monitor and all, for less than $800.

There are a lot of used CP/M computers about, but you don't seem to see them advertised much. I think many owners are suddenly realising how useful CP/M machines are, and they're hanging onto them. But they still come up, usually from businesses that are finally moving up to IBM-PC's.

If you're lucky you can score a Kaypro or Osborne Executive (semi-portable computers), for 10 to 20% of their original cost. And most will come with software included. You may even get the computer with WordStar, Cardbox, and Supercalc, all in one hit!

Shareware software can be obtained in one of two ways. There are companies in Australia that specialise in Shareware; they usually sell the stuff for around $10-15 a diskful.

These are trial versions of the software; if you end up using it you are expected to send a fee to the software author who then sends you the complete version. This could be around $30-50 for a word processor, but it's still very cheap compared with the commercial stuff. Shareware is also distributed through the many computer bulletin boards around the country. You ring them up and then use your modem to download the programs onto your own disks. Once again you're expected to pay the author if you actually use the software.

Most of the information this month has pertained to home and small business uses of computers. Next time we'll concentrate on the pure electronics side of things, and find out how old machines such as Microbees, Commodore 32's and 64's, and Apple II's can be useful in an electronics workshop.

You get more for your dollar with Rod Irving Electronics!

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CENTRONICS CONNECTORS

- 14 Way plug P12205
- 24 Way plug P12207
- 36 Way plug P12210

1-9	10+	100+
$2.95	$2.50	$2.00

SOLDER CENTRONICS IN-LINE SOCKET

- 36 Way P12211

1-9	10+
$4.50	$4.95

IDC SOCKETS

.1" SPACING

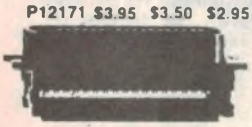
	1-9	10+
• 10 Pin P12100	$1.95	$1.75
• 16 Pin P12101	$1.75	$1.50
• 20 Pin P12102	$1.95	$1.75
• 26 Pin P12103	$1.95	$1.75
• 34 Pin P12104	$2.00	$1.80
• 36 Pin P12106	$3.00	$2.50
• 40 Pin P12108	$3.50	$3.25

D TYPE IDC PLUGS

	1-9	10+	100+
• DE9P 9 pin plug P12166	$2.95	$2.50	$2.00
• DA15P 15 pin plug P12168	$3.50	$3.00	$2.50
• DB25P 25 pin plug P12170	$3.95	$3.50	$2.95

D TYPE IDC SOCKETS

	1-9	10+	100+
• DE9S 9 pin socket P12167	$2.95	$2.50	$2.00
• DA15S 15 pin socket P12169	$3.50	$3.00	$2.50
• DB25S 25 pin socket P12171	$3.95	$3.50	$2.95



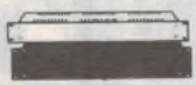
IDC CENTRONICS 36 WAY PLUG & SOCKET

	1-9	10+	100+
• Plug P12200	$3.95	$3.00	$2.95
• Socket P12201	$3.95	$3.00	$2.95

OMNI-DIRECTIONAL WIRELESS MICROPHONE

Tuneable: 92 - 104MHz
Freq. Response: 50 - 15kHz
Range: Over 300 feet in open field
Modulation: FM
Power Source: 9V Battery
Type: Electret Condenser
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

Cat A10450 $24.95



MASTER RACK MOUNTING CABINETS

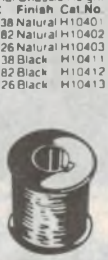
These superb rack mount cabinets will give your projects a real professional appearance! Just look at these features

- All dimensions conform to the International Standard
- All aluminium construction
- Choice of black or natural finish
- Deluxe brush finish anodised front panel
- Removeable top and bottom lid
- Ventilated lid

Horizontal Depth: 254mm

A External Front Panel Height mm
B Mounting Hole Centres mm
C Internal Chassis Height mm

A	B	C	Finish	Cat No.	Price
44	34	38	Natural	H10400	$59.50
88	57	82	Natural	H10402	$69.50
132	89	126	Natural	H10403	$79.50
44	34	38	Black	H10411	$65.00
88	57	82	Black	H10412	$75.00
132	89	126	Black	H10413	$85.00



SOLDER ROLLS

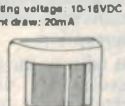
Absolutely top quality - unlike our opposition's! 60/40 Resin cored

Cat No.	Description	Price
T31000	71mm 250gm	$8.95
T31002	71mm 500gm	$15.95
T31010	91mm 250gm	$7.95
T31012	91mm 500gm	$14.95
T31020	1.6mm 250gm	$7.50
T31022	1.6mm 500gm	$13.95
T31030	71mm 1 metre	$1.50
T31032	91mm 1 metre	$1.25
T31034	1.6mm 1 metre	$1.00

PASSIVE INFA-RED DETECTORS

These dual element passive infa-red detectors are a very reliable way to ensure security and protection when used in conjunction with an alarm panel. They detect rapid changes in temperature which is emmitted by an intruder. They are in a compact beige coloured cabinet designed for either wall or corner mounting.

- Normally closed relay, tamper outputs and LED walk indicator.
- Operating voltage: 10-16VDC
- Current draw: 20mA



Protects normal sized rooms.
- Covers an area 12m x 12m

$69.95

Protects corridoors & hallways
- Covers an area 25m x 3m

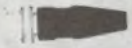
$69.95

BNC MALE PLUG

1-9	10-99	100+
P10514 $2.50	$2.25	$1.50

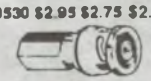
BNC PANEL SOCKET

1-9	10-99	100+
P10516 $2.50	$2.25	$1.50



BNC CRIMP PLUG

1-9	10-99	100+
P10530 $2.95	$2.75	$2.00

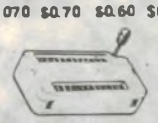


BNC SOLDERLESS TWIST ON PLUG

1-9	10-99	100+
P10531 $2.50	$2.25	$2.00

MINI MOMENTARY PUSH BUTTONS

	1-9	10+	100+
• push on S11060	$0.60	$0.55	$0.50
• push off S11070	$0.70	$0.60	$0.50



TEXTOOL IC SOCKETS (ZERO INSERTION FORCE)

These ZIF sockets are perfect for inserting and removing EPROMS so as not to damage the IC pins.

	1-9	10+
• 16 pin P17016	$16.95	$13.95
• 24 pin P17024	$19.95	$18.50
• 28 pin P17028	$26.95	$24.95
• 40 pin P17040	$34.95	$32.95

10dB IN-LINE COAXIAL AMPLIFIER

Reduces loss from splitters and long cable runs. Suitable for use with antennas, coaxial feed lines and VCR's. A.C adaptor included.

SPECIFICATIONS
Frequency Range: 5-900MHz
Gain: 10dB
Power Requirements: 12V A.C Adaptor (included)
Input Impedance: 75 ohm
Output Impedance: 75 ohm

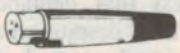
Cat L15043 $39.95

CANNON TYPE 3 PIN LINE MALE

1-9	10+	100+
P10960 $4.75	$3.90	$3.00

CANNON TYPE 3 PIN CHASSIS MALE

1-9	10+	100+
P10962 $3.95	$3.50	$2.90

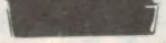


CANNON TYPE 3 PIN LINE FEMALE

1-9	10+	100+
P10964 $4.50	$4.20	$3.20

CANNON TYPE 3 PIN CHASSIS FEMALE

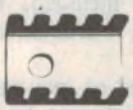
1-9	10+	100+
P10966 $5.95	$5.50	$4.00



RECHARGEABLE 12V GELL BATTERIES

Leakproof and in 3 convenient sizes, these long service life batteries are ideal for burgular systems, emergency lighting or as a computer backup power supply ideal for many power needs.

Cat S15029 12V 1.2 AH $29.50
Cat S15031 12V 2.6 AH $39.50
Cat S15033 12V 4.5 AH $49.50



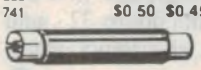
MINIATURE HEATSINK

A great little fellow if you are short of spare. Great price for the because we import direct so you save! Dimensions 19(L) x 19(W) x 9(H)mm

Cat No.		
H01606	$0.40	$0.35

VOLTAGE REGULATORS BARGAINS

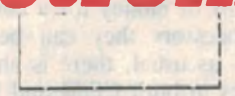
Description	1-9	10+
7805UC	$0.50	$0.45
7812UC	$0.50	$0.45
7815UC	$0.50	$0.45
7905UC	$0.60	$0.55
7912UC	$0.60	$0.55
7915UC	$0.60	$0.55
78L05	$0.45	$0.40
78L12	$0.45	$0.40
LM324	$1.00	$0.90
555	$0.40	$0.38
741	$0.50	$0.45



TV INTERFERENCE FILTER

Cuts CB Ham signals interference

Cat L11048 $5.95



BREADBOARDS

Cat No.	Description	Price
P11000	100 Holes	$ 2.75
P11005	640 Holes	$10.75
P11007	640 - 100 Holes	$14.95
P11009	640 - 200 Holes	$17.50
P11010	1280 - 100 Holes	$26.95
P11011	1280 - 300 Holes	$32.50
P11012	1280 - 400 Holes	$39.95
P11015	1920 - 500 Holes	$59.95
P11018	2560 - 700 Holes	$69.95

3M DYNAMARK PHOTOSENSITIVE

(EX SCOTCHCAL)

All prices per box and include tax

8007 REVERSAL FILM	250 x 300mm (10 sheets)	$39.95
	300 x 600mm (5 sheets)	$54.95
8005 BLACK ALUMINIUM	250 x 300mm (10 sheets)	$69.95
	300 x 600mm (5 sheets)	$79.95
8009 BLUE ALUMINIUM	250 x 300mm (10 sheets)	$69.95
	300 x 600mm (5 sheets)	$79.95
8011 RED/WHITE	250 x 300mm (10 sheets)	$64.95
	300 x 600mm (5 sheets)	$74.95
8013 BLACK/YELLOW	250 x 300mm (10 sheets)	$64.95
	300 x 600mm (5 sheets)	$74.95
8015 BLACK/WHITE	250 x 300mm (10 sheets)	$64.95
	300 x 600mm (5 sheets)	$74.95
8016 BLUE/WHITE	250 x 300mm (10 sheets)	$64.95
	300 x 600mm (5 sheets)	$74.95
8018 GREEN/WHITE	250 x 300mm (10 sheets)	$64.95
	300 x 600mm (5 sheets)	$74.95

TELECOMMUNICATION CURL CORD

- U.S. plug to U.S. plug
- Replacement hand set cord
- Length 4.5 metres

Cat Y16023 $7.95

SPECTROL 64Y MULTI TURN TRIMPOTS

Cat No.	Description	1-9	10+
R14700	10R	$3.50	$3.20
R14710	20R	$3.50	$3.20
R14720	50R	$3.50	$3.20
R14730	100R	$3.50	$3.20
R14740	200R	$3.50	$3.20
R14750	500R	$3.50	$3.20
R14760	1K	$3.50	$3.20
R14770	2K	$3.50	$3.20
R14780	5K	$3.50	$3.20
R14790	10K	$3.50	$3.20
R14800	20K	$3.50	$3.20
R14810	50K	$3.50	$3.20
R14820	100K	$3.50	$3.20
R14830	200K	$3.50	$3.20
R14840	500K	$3.50	$3.20
R14850	1M	$3.50	$3.20

INSULATION DISPLACEMENT TYPE HEADER PLUGS

Gold plated ribbon cable plug that plugs directly into PCB mounting IC sockets. All include press-fit cap that fits into bottom half of plug over IDC cable.

Cat No.	Description	1-9	10
P12114	14 pin	$1.50	$1.40
P12116	16 pin	$1.60	$1.50
P12124	24 pin	$2.95	$2.75
P12140	40 pin	$5.95	$5.75

RS232 GENDER CHANGERS

- Saves modifying or replacing non-mating RS232 cables
- All 25 pins wired straight through

Cat X15650 Male to Male
Cat X15651 Male to Female
Cat X15652 Female to Female

$8.95

CENTRONICS GENDER CHANGERS

- Female to Female
- Saves modifying or replacing non-mating Centronics cables
- All 36 pins wired straight through

Cat X15663 Male to Male
Cat X15661 Male to Female
Cat X15664 Female to Female

$19.95

UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety in about 40 minutes (less for less chips)

Features include

- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

WITHOUT TIMER
Cat X14950 $119

WITH BUILT-IN TIMER
Cat X14955 $149

ROD IRVING ELECTRONICS

SYDNEY: 74 Parramatta Rd, Stanmore, NSW. Phone: (02) 519 3134

MELBOURNE: 48 A'Beckett St. Phone: (03) 663 6151

NORTHCOTE: 425 High St, Melb. Phone: (03) 489 8866

CLAYTON MAIL ORDER: 56 Renver Rd, Phone (03) 543 7877 Fax: (03) 543 2648

E&OE Errors & Omissions Excepted

IBM, PC, XT, AT, are registered trademarks of International Business Machines. Apple is a registered trademark of Apple Corporation.

MAIL ORDER & CORRESPONDENCE:
P.O. Box 620 CLAYTON 3168
Order Hotline: 008 33 5757
(Toll free, strictly orders only)

POSTAGE RATES

$1 - $9.99	$3.00
$10 - $24.99	$3.50
$25 - $49.99	$4.50
$50 - $99.99	$6.00
$100 - $199	FREE
$200 - $500	FREE
$500 PLUS	FREE

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

All sales tax exempt orders and wholesale inquiries to RITRONICS WHOLESALE 56 Renver Rd Clayton Ph (03) 543 2166 (3 lines)

MasterCard VISA

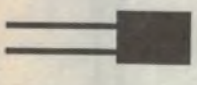
GREAT SAVINGS

ROD IRVING ELECTRONICS

PCB MOUNTING SCREW TERMINALS (INTERLOCKING ENDS)

These terminals feature interlocking ends to form any number of connections. Standard 5mm spacing pins.

	1-9	10+	100+
• P10520 2 way	$0.75	$0.70	$0.60
• P10521 3 way	$1.00	$0.90	$0.80



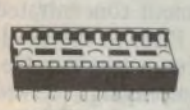
RECTANGULAR LEDS

	1-9	10-99	100+
RED	20c	15c	12c
GREEN	20c	15c	12c
YELLOW	20c	15c	12c
ORANGE	20c	15c	12c

GOLD INSERT LOW PROFILE IC SOCKETS

- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service components is required.

Cat no.	Description	1-9	10+
P10620	8 pin	$1.20	$1.10
P10624	14 pin	$1.60	$1.40
P10626	16 pin	$1.90	$1.80
P10628	18 pin	$2.00	$1.90
P10630	20 pin	$2.20	$2.00
P10632	22 pin	$2.40	$2.20
P10634	24 pin	$2.60	$2.40
P10640	28 pin	$2.90	$2.70
P10644	40 pin	$2.95	$2.75



LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct Import" low profile ic sockets! PCB mounting solder tail. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

Cat. No.	Description	1-9	10+
P10550	8 pin	$0.20	$0.18
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.25	$0.20
P10567	18 pin	$0.40	$0.35
P10568	20 pin	$0.40	$0.35
P10569	22 pin	$0.40	$0.30
P10570	24 pin	$0.40	$0.30
P10572	28 pin	$0.50	$0.40
P10575	40 pin	$0.50	$0.40

INSIDE THE IBM PC

(Revised and expanded edition) -Peter Norton

The widely acclaimed guide to the IBM PC's inner workings. The latest edition now covers every model of the IBM micro: PC, XT and AT, and every version of DOS from 1.1 to 3.0

B20080 ..... $44.95

12V DC FANS

80 x 80 x 25.4mm
12V DC, 1.7 Watt, 0.14 Amps
T12469.....$12.95
10+ fans only $11.95 each

MICE

QUICK MOUSE

MICROSOFT™ COMPATIBLE!

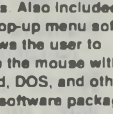
- Auto-selection and auto-transfer between mouse system system PC mouse mode and Microsoft serial mouse mode
- Microsoft Serial Mouse and Mouse System compatible
- Super high tracking speed: 600mm/sec
- Super high resolution: 200 D.P.I. (0.12mm/dot)
- Silicon rubber coated ball
- Optical rotary encoder

X19952.....$79.00

WITTY MOUSE

- Three buttons, user definable
- Silicone coated steel ball
- High resolution movement of 195 dots/inch. Smaller table space and less hand movement required
- Optical rotary encoder
- Max. tracking speed: 200m/sec
- Mouse resident firmware
- Size: 116 x 66 x 34mm
- Mouse Driver Software included, allowing you to install with all popular software packages. Also included is the handy Pop-up menu software that allows the user to integrate the mouse with the keyboard, DOS, and other popular software packages

X19950.....$59

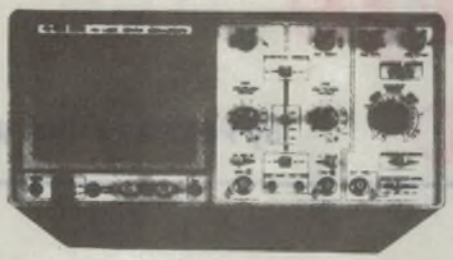


FLASHING LEADS

- Red, 5mm

	1-10	10+
Z10159	$1.10	$1.00

NEW CRO'S



20MHZ DUAL TRACE OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

VERTICAL DEFLECTION
- Deflection Factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Bandwidth DC: DC to 20MHz (-3dB)
  AC: 10Hz to 20MHz (-3dB)
- Operating Modes: CH-A, CH-B, DUAL and ADD (ALT/CHOP L202 only)
- Chop Frequency: 200KHz Approx.
- Channel Separation: Better than 60dB at 1KHz

TIME BASE
- Type: Automatic and normal triggered in automatic mode, sweep is obtained without input signal
- Sweep Time: 0.2µ Sec to 0.5 Sec/ Div on 20 ranges in 1-2-5 step with fine control and X-Y
- Magnifier: X5 at all ranges

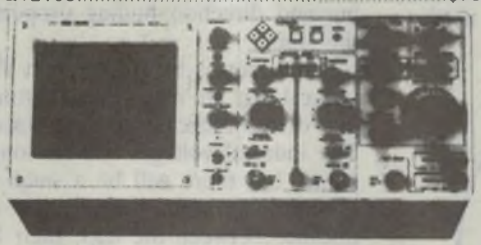
TRIGGERING
- Sensitivity Int: 1 Div or more
  Ext: 1Vp-p or more
- Source: INT, CH-B, LINE or EXT
- Triggering Level: Positive and Negative, continuously variable level; Pull for Auto
- Sync: AC, HF Rej, TV (each + or -) at TV Sync. TV-H (line) and TV-V (Frame) sync. are switched automatically by SWEEP TIME/Div switch.

CRO Probe to suit $39.50 each - Cat. Q12201.

HORIZONTAL DEFLECTION
- Deflection factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Frequency Response: DC to MHz (-3dB)
- Max Input Voltage: 300V DC + AC Peak of 600Vp-p
- X-Y Operation: X-Y mode is selected by SWEEP TIME/ Div switch
- Intensity Modulation Z Axis: TTL Level (3Vp-p-50V) + bright, - dark

OTHER SPECIFICATIONS
- Weight: 7Kg Approx.
- Dimensions: 162(H) x 294(W) x 352(D) mm

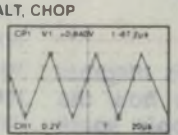
Q12105.....$750



40MHZ READ-OUT OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

VERTICAL AMPLIFIER (CH1 and CH2 Identical)
- Operational Modes: CH1, CH2, ADD, DUAL, ALT, CHOP
- Sensitivity: 5mV-5V/ Div 3% in 1-2-5 steps
  1mV-1V/ Div ±5% x5MAG
- Bandwidth DC: DC to 40MHz (-3dB)
  AC: 5Hz to 40MHz (-3dB)
- Rise Time: Less than 8.7nS



L - Readout Display

HORIZONTAL AMPLIFIER
- Operating Modes: X-Y operation CH1-X axis, CH2-Y axis
- Sensitivity: 5mV-5V/ Div ± 3% in 1-2-5 steps
- Input Impedance: 1MΩ±2%, 25pF±3%
- Bandwidth DC: DC to 1MHz (-3dB)
  AC: 5Hz to 1MHz (-3dB)

CRO Probe to suit $39.50 each - Cat. Q12201

TIME BASE
- Sweep Method: AUTO, NORM, SINGLE
- Sweep Time (A): 0.2µs-0.5S/ Div ±3% in 1-2-5 steps (X1 only)
  (B): 0.2µS-0.5mS/ Div ±3% in 1-2-5 steps (X1 only)
- Magnified Sweep: 10 times ±5%, Max 20ns
- Linearity: ±3% or better

Q12107.....$1,695

METEX M-3650 MULTIMETER

20A, 3½ digit frequency counter multimeter with capacitance meter and transistor tester.

This spectacular, rugged and compact DMM has a bright yellow high impact plastic case. It features a frequency counter (to 200kHz), diode and transistor test, continuity (with buzzer), capacitance meter, up to 20 amp current measurement and comprehensive AC/DC voltage, current and resistance ranges.

CHECK THESE FEATURES
- Push button ON/OFF switch
- Audible continuity test
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Transistor test
- Diode test
- Quality probes
- ½" High contrast LCD
- Full overload protection
- 20 Amp
- Built in tilting bail
- Capacitance meter
- Instruction manual

Q91550 ..... Normally $165
Special, only $129

FREE

100 PAGE CATALOGUE PLEASE CALL IN AND PICK ONE UP

METEX 3530 MULTIMETER

Compact, rugged, battery operated, hand held 3½ digit multimeter.

Features...
- ½" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- Capacitance measurements to 20uF
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS

Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0-C to +40-C.
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 **Normally $139**
SPECIAL $99

Vintage Radio

by PETER LANKSHEAR

Loop aerials

The first ever receiving aerial was a loop – a type of aerial that has had periods of limited popularity. Today its descendants dominate broadcast band reception.

The German physicist Heinrich Hertz is generally credited with putting the science of electromagnetic radiations on a firm footing. During the years 1886-88, he conducted a series of experiments to confirm the existence of the phenomena that had been predicted in 1864 by the Scottish mathematician James Clerk Maxwell. Many of Hertz's experiments were conducted in what is now known as the VHF band, and the receiver he most frequently used incorporated a directly excited single-turn tuned circuit that was in fact, a loop aerial.

With his loop, Hertz was able to prove that electromagnetic waves behaved like light in that they could be directed, reflected and refracted. He also observed that the orientation of the loop affected the intensity of the received signal.

Since then, loops have come in many different shapes and sizes. Generally multi turn, it is today most used at medium and low frequencies.

Fig.1: Hertz's receiver. This diagram from a 1906 book shows how the loop included a microscopic spark gap which discharged on receiving a signal. It has been estimated that at least 300 volts would have been necessary to create a visible spark. But with this elementary and insensitive equipment, Hertz was able to prove Maxwell's predictions of the behaviour of radio waves.

Wound on a cruciform wooden frame as either a flat spiral or as a box, the loop aerial became one of radio's early symbols. To be domestically acceptable, some were made to be folded for easy storage. Today, use of the loop in its modern form as the ferrite rod antenna is almost universal.

How loops work

As there is a detailed analysis of loop operation in just about every book on radio fundamentals, this description will be brief.

The electromagnetic component of a passing radio wavefront generates voltages in the vertical portions of the loop, but nothing in the horizontal sections. If the vertical legs are in the plane of the radio wave, there will be equal voltages generated in each. These will cancel and the net result at the terminals will be nil, accounting for the well known nulling and direction finding properties of the loop.

If the loop is turned through 90°, the vertical legs are now spaced through the line of the cyclically moving wavefront. The induced voltages will no longer be equal, but there will be a small difference voltage which is dependent on the distance between the legs, their length, and the number of turns. This difference voltage becomes the useful output of the loop.

Provided that there are no re-entrant components, the shape of the loop is unimportant and it can be rectangular, square, triangular or even circular. Output is proportional to area and significantly, height above the ground is unimportant.

Early uses

During the last decade of the 19th century, workable systems of wireless telegraphy evolved. Increased transmission range was a prime requirement, and, following Marconi's discovery that

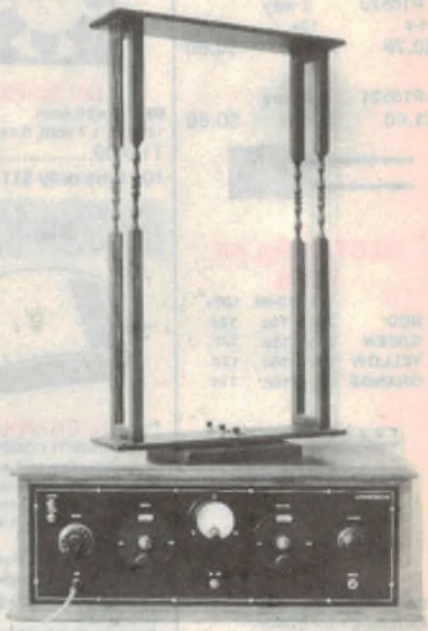


Fig.2: Homebuilt box loop and superheterodyne receiver from the late 1920's. The loop is centre tapped, to enable regeneration to be applied to the RF amplifier valve. Many early superhets used a self-oscillating mixer coupled to the aerial.

elevated wires improved signal strengths considerably, development concentrated on large open aerials. Prior to the availability of the high vacuum triode valve, there was no way of amplifying received signals, and the big Marconi aerial was essential to extract sufficient energy for reasonable reception. Loop aerials were far too inefficient for practical communications.

Nevertheless, during 1905, H.J. Round of the Marconi Company investigated the direction-finding properties of loop or frame aerials. This characteristic had important implications for marine radio location, and the outbreak of the 1914-1918 war stimulated further re-

search. The high vacuum triode valve had recently become available, and RF amplification of loop signals, although somewhat inefficient, was possible.

Loops in WW1

Honouring H.J. Round in an address to the Radio Club of America in 1952, Edwin Armstrong – of superhet and FM fame – related how his friend Captain Round had by 1916, developed a stable RF amplifier with no less than 19 stages of amplification! This was used in conjunction with a direction finding loop to eavesdrop on the German Navy, safe at anchor in Willemshaven, 300 miles away. The unsuspecting Germans actually used plain language for their traffic, not imagining that they were being monitored.

Armstrong quoted from the memoirs of the First Sea Lord, Admiral Sir Henry Jackson, who was himself a naval radio pioneer. Jackson wrote how one day Round's direction-finding equipment had indicated that the source of the signals from one of the German ships had changed position about 1.5°. This alerted the British Admiralty to the possibility that the Germans were putting to sea, and the order was given to the Royal Navy's Grand Fleet to intercept them. The German fleet was located and the outcome on the 31st May 1916 was the great Battle of Jutland. Already, the loop aerial was a vital piece of equipment in marine radio.

During the early post war period, the prime application of the loop was as a direction-finding aid. It is useless as a transmitting aerial and its low efficiency meant that there was little incentive to use it as a receiving aerial for normal communication work. It was no match for the large wire aerials that were readily erected on ships and at land stations.

With the development of broadcasting in the early 1920's, the emphasis was still on aerial efficiency. At first, transmitters were low powered and receivers insensitive. In the United States, as in Australasia, listeners were frequently long distances from transmitters, many of which were low powered. Large aerials, today erroneously called 'longwire', were essential and forests of poles sprouted in back yards.

Britain different

In England, the situation by the late 1920's was somewhat different. The country had good coverage from a network of high powered transmitters, and although many listeners could only afford crystal sets which did need large aerials, loops could often provide adequate reception with multi-valve radios.

Many listeners preferred their radios to be movable. In his book *Radio Radio*, Johnathan Hill claims that around 1926, portables had a leading share of the British market. It was common for these receivers to have a loop aerial either in the lid or wound around the inside the cabinet. During most of the year, they were used as domestic receivers, but could be taken outdoors if and when the weather permitted.

Here, and in America, portable receivers had not been anywhere near as common as in Britain. However, prior to 1930, many of the early superheterodynes did use loop aerials. A major reason was that they frequently used a self-oscillating mixer valve, which could radiate a considerable amount of interference if coupled to a large aerial. Early New Zealand radio regulations actually required superheterodyne receivers to use loop aerials!

The early RCA superhets were often supplied with ornate loop aerials and some sensitive American neutralised-triode TRF receivers were provided with loop aerials that could be folded away inside the cabinet when not in use. By the use of a jack plug that disconnected the input tuning coil, use of the loop could be optional.

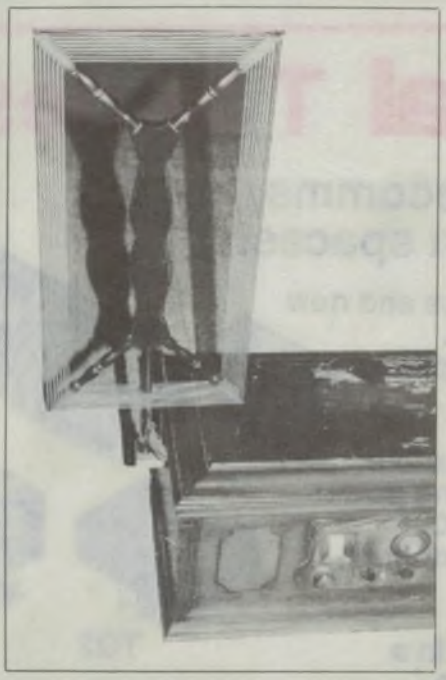


Fig.3: This spiral loop belongs to an American FADA model 480B Neutrodyne receiver built in 1927, and can be folded away in the top of the receiver when not in use. Only a few large US receivers from this period were supplied with loops. The 480B used four tuned RF and three audio stages.

Loops in decline

The situation changed after 1930 with the widespread use of mains power and the modern high gain and stable superhet. Often, a short piece of wire was adequate for an aerial.

For most of the decade, loop aerials and portables were generally neglected. The term 'portable' still referred to the provision of carrying handles rather than compactness and convenience, and running costs were high.

In America, car radios, for which the loop aerial was not satisfactory, became popular during the 1930's, and the few portables that were produced had wire aerials. Here the situation was much same. The STC 506 portable described in *EA* for April 1989 was typical. Although it had a door suitable for housing a loop, a wire aerial was preferred, and the chassis was no different from the household model.

Revival

In 1939, the advent of the new 1.4 volt battery valves meant that portable radios could live up to their name, rather than just being radios with handles.

Portables suddenly became popular here and in America, and now with them, loop aerials. These were generally flat spirals, mounted in the lid or back of the cabinet.

The same manufacturers 'discovered' that loop aerials were also very practical for mains powered receivers, something that a small number of British manufacturers had never forgotten. Terminals were generally provided so that the user could connect a conventional aerial if desired.

Most of these loop-fitted receivers were small 'mantle' sets, popular for apartments and 'second sets'. But one American manufacturer, General Electric, brought out an ambitious model using their 'Beam-A-Scope' loop aerial. A large console cabinet contained a rotatable loop fitted with a Faraday electrostatic shield. By shielding the aerial, much local electrical interference would either not be picked up, or could more readily be nulled out.

Monster loop

What must be one of the biggest loops ever, was built around 1940 by the New Zealand Post Office for receiving long-wave transmissions direct from Rugby in England. As I recall, it was about 10 metres square, constructed between two large telegraph poles. Each pole was fitted with four standard 8-insulator cross arms, supporting 16 turns

in two layers. Total length of wire would have been something like 600 metres!

By the early 1950's radio coverage had improved considerably and extreme sensitivity was no longer necessary. Loop-equipped receivers became increasingly popular, due in part to the absence of dangling leads and random bits of wire.

Around this time, the 'DX' (long distance reception) fraternity started taking loops very seriously. In reception of the now-crowded broadcast band, the combination of the directional properties of large tuned loop and a sensitive receiver worked wonders in digging out elusive signals.

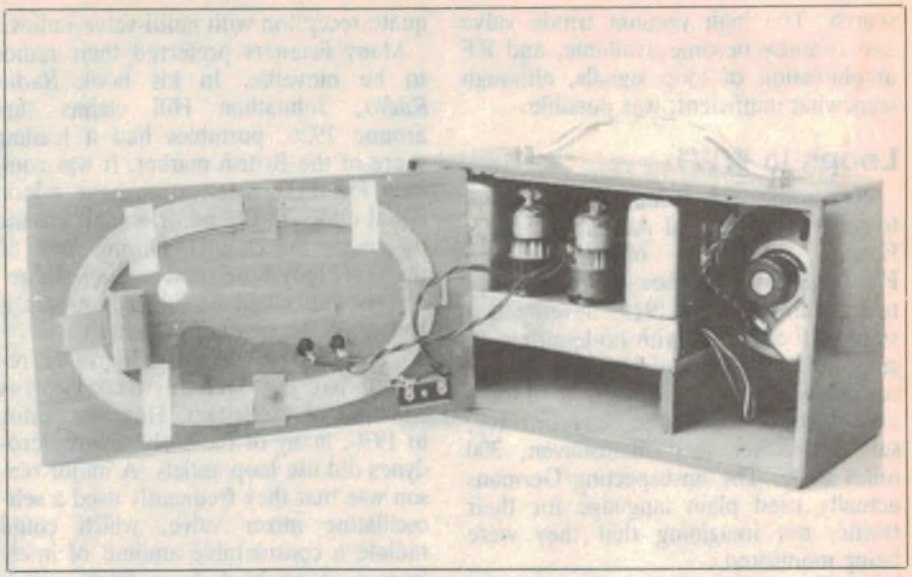


Fig.4: By 1947, portable receivers were reasonably small and were able to produce acceptable results from small built-in loop aerials. This one is mounted on the back panel of the case.

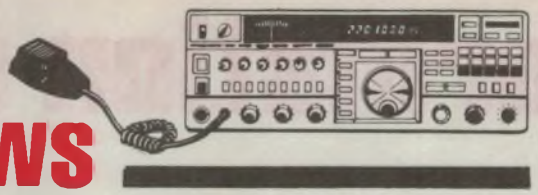
Iron cored loops

Also, during the mid 1950's one of the most significant developments in domestic loop aerials appeared, in the form of the familiar *ferrite rod aerial*. This is, in reality, a small diameter loop with a powdered-iron core to intensify the electromagnetic field. Performance is roughly equivalent to that of a loop with a diameter equal to the rod's length, and its small size restricts unwanted electrostatic pickup as well as making it physically convenient.

It was fortunate that the ferrite aerial turned out to be ideal for coupling to bipolar transistors. Had the ferrite loop not been available, it is unlikely that the small transistor AM radio as we know it would have evolved, and today's domestic radio situation would be very different.

Now, a century after the Hertz experiments, there are millions of ferrite loops in use, and there is no immediate threat to their continuing and justified popularity.

Amateur Radio News



Aust. & world records — continued

Here's the second part of the listing of current Australian records for VHF, UHF and SHF contacts, kindly sent in by John Martin VK3ZJC, Acting Chairman of the WIA's Federal Technical Advisory Committee (FTAC). As promised this part lists the records for EME, ATV, mobile and digital modes, as they stood in April this year. As before the 'N' code shows a national record.

Also shown are the current world records, for both terrestrial and EME contacts. Where a band is not listed, there is no current record claimed.

Current World Records

Band	Terrestrial	EME
50MHz		13256km
70MHz	3465 km	
144MHz	7860 km	19455km
220MHz	5906 km	8139km
432MHz	4103 km	18783km
576MHz	382.9km	
903MHz	769 km	30km
1296MHz	4068 km	18657km
2300MHz	1885.5km	13931km
3300MHz	1885.5km	802km
5650Mhz	981 km	279km
10GHz	1660 km	
24GHz	331 km	
47GHz	87 km	
75GHz	0.5km	
474GHz	15 km	

Australian Records

		EME Category		
144MHz N	VK3ATN	to K2MWA/2	28/11/66	16761.0km
432MHz N	VK6ZT	to K2UYH	29/01/83	18726.4km
1296MHz N	VK3AKC	to W2NFA	06/10/73	16713.0km (3)
		ATV Category		
432MHz N	VK7EM/T	to VK3ZPA/T	13/12/72	413.0km (4)
		Mobile Category		
144MHz N	VK3KAJ/M	to VK6BE	25/01/86	2224.5km
432MHz N	VK3KAJ/M	to VK6BE	25/01/86	2224.5km
576MHz N	VK3KAJ/M	to VK3ZBJ	26/02/89	122.5km
1296MHz N	VK3ZJC/M	to VK3KKW/M	16/09/89	137.6km
		Digital Modes Category		
50MHz N	VK3ZJC	to VK8ZLX	26/12/88	1906.3km

NOTES: (3) VK3AKC: R. Wilkinson (deceased)
(4) VK3ZPA now licensed as VK3KAU

Free licence examinations

An organisation called West Ham Examinations has been set up in the west of Sydney, to provide an independent, economical alternative for those wishing to sit for the AOCP examinations.

Normal fees are set at the low fee of $5 per subject. But for high school students and members of the NSW Division of the WIA, the fees are to be waived.

Regular examinations will be held at Birrong Boys' High School, with country candidates and clubs invited to use WHE's exam papers under local supervision. Exams are scheduled for August 12, October 14 and December 9.

Further information is available from West Ham Examinations, 13 Iris Street, Sefton 2162 or phone (02) 644 9193.

Move for new QSL bureau

A group of Victorian amateurs is apparently unhappy with the methods used by the WIA's Victorian Division in dealing with incoming QSL cards for non members. The group is seeking user and/or moral support from other amateurs, for the idea of setting up an alternative Victorian/Australian QSL bureau.

The initial intention is to set up an 'inward bureau' only, on the 'return envelope' basis.

Amateurs are invited to register their support by writing to PO Box 432, Abbotsford 3067. If there is insufficient response, no further research will be conducted and the concept will be shelved.

Information centre

Conducted by Peter Phillips

Shedding some light on the subject

Ever wondered what a 'fiscal horse' is? Or why some fluorescent light circuits use filament heating and others don't? Find out the answer to these questions and more, in this month's exciting collection of reader letters.

Now that the magazine *ETI* has been merged with *EA*, letters concerning *ETI* projects are making their way to my desk. No problem – I spent several years with *ETI* before joining *EA*, and have a working familiarity with at least *some* of *ETI's* projects. Unfortunately, my filing system such as it is does not include all past issues of *ETI*, and references to a particular project usually require me to access the circuit.

In the interests of being able to offer assistance on these projects, I have a small request. If you want some help with projects from *ETI*, please send a photocopy of at least the 'How it Works' section and the circuit diagram. This doesn't guarantee an accurate response, or even a response that is useful, but it will help me considerably in answering your questions.

We also occasionally get letters about projects from other electronics magazines, both local and imported. Usually we cannot help with these, unless the answer is of a very general nature and of interest to all readers. Again a copy of the circuit will help, but don't be too upset if we fail to respond on these types of requests.

We'll start with two letters that fall into the category of those I've just mentioned, followed by a most varied range of topics.

VU meter

The following letter asks our advice about a mixer circuit from the magazine *Hobby Electronics*. Because the question is not really about the circuit we don't mind helping out with this one. Normally we'd say nasty things like ask them, but the question is not specific to the project and our answer is probably of general interest.

I have recently constructed a mixer circuit from the magazine Hobby Electronics, (HE 112), and found it worked very well. I now wish to add a VU meter to the output to monitor the level of the audio output signal. To this end, I have scrounged a VU meter from an old tape recorder, and have tried connecting it in series with a 10k pot and a diode to the output of the mixer.

However, the needle only stays at the setting determined by the pot, and doesn't fluctuate with the audio level. Can you assist me with this, as I wish to use the meter to indicate the relative outputs of a camera, a microphone and some music for recording onto a VCR. (D.S., Frankston Vic).

The circuit of the mixer was supplied by D.S., and consists of an LM301 op amp connected as a two input summer. The gain of one channel is set to a maximum of 100 (mic input), and the other to a maximum gain of one. The output, which is biased to 4.5V DC as the op amp is supplied by a single 9V battery, connects to a socket via a 10uF capacitor.

A VU meter circuit that works (I tested it, by the way) is shown in Fig.1, which seems to be similar to that described by D.S., although he did not mention using a capacitor across the meter as shown in my circuit (C2). The only effect this capacitor will have is to increase the deflection, so its exclusion is not a reason for the circuit to indicate a steady value rather than the audio level.

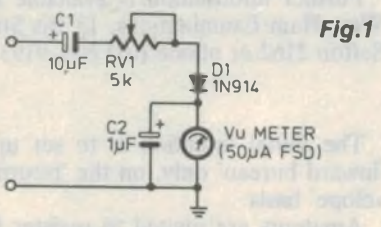


Fig.1

It seems clear that there is a DC component affecting your meter, D.S., either caused by a faulty coupling capacitor or a wrong connection. The meter *must* have a capacitor in series with it (C1), and if this is an electrolytic type, it needs to be correctly polarised.

Chopper effects unit

The next letter asks about an *ETI* project. The correspondent didn't send a circuit but as it turns out, I can help anyway.

Looking back through past issues of ETI, I encountered a circuit of a Chopper Echo-Effects Unit on page 106 of the January 1984 issue. The only worry with this circuit is the VN67AF FET, which no one seems to have heard of. Please help, either with the name of a supplier or a substitute for this elusive device. (G.K., Dunkeld Vic).

Whenever I can't find a component, I reach for a Farnell Electronic Components catalog. And yes, they have the VN67AF FET listed, at a price of $2.75. Their address is 72 Ferndell Street, Chester Hill, NSW, 2162, and the phone number is (02) 645 8888.

According to the Farnell catalog, the VN67AF has the following characteristics: N-channel power MOSFET, VDS of 60V, drain current of 1.6A, TO-220 package with the connections shown in Fig.2. Note that the drain tab connects

Fig.2

to the lead on the right, not the usual centre lead.

Feel no pain

Occasionally I like to print items of a humorous nature, and the next letter is certainly that. The original letter was too long to print in its entirety, so I've taken the liberty of condensing it.

On the day in question, my wife joined me after work so we could walk home together. As we passed the local, we decided to share a drink or two with some friends, to wash away the cares of the day. I have to admit that I had somewhat more than two, and as my wife had long since departed for home, alone and most unimpressed, I eventually decided to follow suit.

On the way I came across a man attempting to start his car. He couldn't refuse my effusive 'Wanna hand' and when the engine came into focus I reasoned 'it's either no spark or no petrol.' I decided to test for spark and holding onto the car chassis with one hand and a spark plug lead with the other, I invited him to crank the engine. 'Dead as a dormouse' I informed him after several seconds of testing.

He didn't believe me, so I suggested we change places, to which he timidly agreed. The next thing I recall is seeing this poor man launch vertically as I switched on the ignition and started cranking the engine. As I helped him out of a hedge some three metres from the car, he shook his head and after making oblique references to the Lord, took off.

The next day on my way to work, there he was again, still trying to start the car. As I approached, a look of absolute fear crossed his face, so taking the hint, I kept going. I still wonder how it all happened, but honestly, I never felt a thing! (D.L., Tumblong NSW).

Portable fluoro

I have received three letters that in some way refer to the Portable Fluorescent Light project published in March and April. The first is from a reader who relies on battery power...

Further to the battery powered fluorescent light project, I have a 12V battery light that has two 8W tubes – not working, of course.

Be it Norm Bush's unit, your modified unit or whatever, is the design suitable for 8W tubes? Would I have to use one kit for each tube, or could it be modified suitably to be used to run both tubes?

Hope I'm not being a pain. Keep up the good work. (R.H., Glenreagh NSW).

Of course you aren't 'being a pain', R.H., thanks for taking the trouble to write to us. As the circuit stands, it should be able to operate an 8W tube quite successfully. However, it would not be able to operate two 8W tubes without severe overload and probable damage to the transistor.

Norm Bush has since informed me that he is working on a unit that will operate higher wattage tubes, intended to be run from a car battery rather than being portable. In the meantime, a 12/240V inverter circuit for an 18W fluorescent tube was described in the Circuit and Design Ideas (CDI) section of the January 1990 edition, which may be suitable for driving two parallel tubes. It will need some adaptation however, and the simplest way is to purchase an 18W tube rather than try adapting two 8W tubes.

The next letter asks a question that I really cannot answer!

I have come across some difficulty with the low-cost fluoro lamp project that appeared in EA March/April, 1990. I have two transformers exactly like the one shown in the photo on the bottom of page 71 of the March issue. My problem is that I don't know which wire on the transformer corresponds to the ones shown on the circuit diagram above the photo. Can you tell me which wire goes where; they are all different colours on the transformer? (G.S., Loftus NSW).

In a word, G.S., No! Even though the transformer may look the same, the windings inside are most unlikely to have the same number of turns as those specified in the project. I suggest you dismantle the transformer, unwind each of its windings and then rewind it as described in the article. You may even be able to use the original wire, providing it is not damaged and is around the size specified. This way, you can use the core and maybe the wire, but don't try as it stands.

The layout diagram has numbers next to each wire, which correspond with similar numbers on the circuit diagram. The numbers on the layout are a bit hard to see, and are simply numbered 1 to 6 from top to bottom. The winding details are shown clearly in Fig.2 on page 72.

The final letter asks why are the heaters sometimes used in a portable fluorescent light circuit.

The articles in the March and April issues on battery fluorescent lamps make no reference to use of the tube filaments as preheaters.

They are most commonly used without pre-heating, but I have noted one combination torch-fluoro and a caravan ceiling light where one filament is preheated, as indicated by two connections to one end. Selectronics in Victoria make inverters that preheat both filaments. This raises interesting questions as to the effects of this feature on circuit complexity, performance and cost. (M.C., Busselton WA).

To the best of my knowledge, the reason tubes are sometimes pre-heated is because the initial firing voltage from the inverter is too low to ionise the gas. By heating the gas, even at one end, ionisation can occur more easily and subsequently at a lower voltage. The CDI circuit referred to above heats one filament and also has an earth plane to get the tube going.

An inverter that gives a very high output under no load is probably not regarded as a good design, due to its inherent poor regulation. However, a 'well designed' inverter is not able to fire a fluorescent tube, so filament heating is required. Obviously an inverter with good regulation is likely to be complex, and filament pre-heating is required as well if it is driving a fluorescent lamp. Which all adds up to overall complexity, making the simpler circuit designed by Norm Bush look rather good.

An article on fluorescent lamps was published in the January 1990 issue of EA, which may throw some more light (pardon!) on the topic.

Patents & French horses

Two letters have arrived that make reference to the May 1990 article I wrote about an old book on dynamos. The first draws attention to that fascinating place called the Patent Office.

I wonder, following your article about the remarkable old book on dynamos, whether you might write a similar article about the Sydney Patent Office. This office is located in Kent Street near the Harbour Bridge, and is virtually a library, containing some incredible literature.

Time spent in this office may well give readers insight into how to make items that could be most useful to them. I have enclosed an example of the sort of literature that the office allows to be photocopied. (G.L., Waratah NSW).

The article supplied by G.L. was indeed most interesting, being a patent specification for an 'improved hand sawing apparatus' designed by one Ernest Zimmerman, and lodged in March 1944. I must admit to not being familiar with

the workings of the Patent Office, or even of its location, so I am most grateful to you G.L., for sending me this information.

If time permits, and the resulting story is sufficiently 'electronic in nature', I will indeed take up your suggestion. In fact, the general topic of patents is likely to be of interest to many readers, and is one well worth pursuing.

The next letter throws some light on the 'cheval de vapeur' referred to in the article about the old book.

I was intrigued by the difference between French and English horses, noted in your article on 19th century dynamos.

The Petit Robert provided the answer: 'un cheval de vapeur (ch)' is 75kg.ms^{-1}, or 735 watts. English horses know nothing of this metric nonsense however, so they will lift 550 foot pounds per second, which equates to around 743W (which might stretch to 746W given good hay).

An interesting sidelight is that the French term 'cheval de vapeur' (steam horse) serves to avoid confusion with another beast 'le cheval fiscaux' (fiscal horse). The symbol for this rather quaint unit is CV, as in the recently deceased 2CV Citroen. A fiscal horse is actually a unit of volume, about one sixth of a litre according to Robert, and is used to determine the registration fee for cars and motorcycles in France.

Thus, the 2CV originally had an engine displacement of around a third of a litre. However the name persisted as an historic feature only, as recent 2CV's actually displace 4CV and may be driven up hills without manual assistance. Not quickly, mind you!

Le Robert is the French equivalent of the Oxford English Dictionary, and has a very large entry on horses. (G.B., Parkside SA).

I enjoy letters like that from G.B., as I love technical trivia. I also share a fond regard of the Citroen car, and always wondered where the term CV came from. At the time of writing the article I figured the difference in the horses to be the time-honoured 735W versus 746W conundrum, but I wasn't sure. My French is un peu poor, so I decided not to offer an explanation in case I was wrong.

Many thanks G.B., both for your letter and for the humorous style you chose. It was most enjoyable to read.

What??

Here's a very simple question that often elicits the wrong answer. A 10uA meter movement is connected in series with a resistor so it can read voltages up to 100V. If the meter is connected to a circuit and indicates 27.9V, determine the equivalent resistance the voltmeter represents at this voltage.

NOTES & ERRATA

432MHZ CONVERTER (June 1990): In the overlay diagram on page 120, there should be black dots on the pads of L4 and VC4 that are not connected to tracks on the underside of the board – indicating a connection to the top ground plane copper. The 90cs5t copper pattern reproduced on page 121 is also in error, showing copper relieved around the leads of C14, C17, C4 and C7 which should connect to the ground plane. The copper is also incorrectly relieved around the emitter leads of Q1 and Q2, whereas it should be shown relieved around the collector leads of both transistors. A revised version of the 90cs5t pattern is reproduced here, and copies have been sent to the various PCB manufacturers.

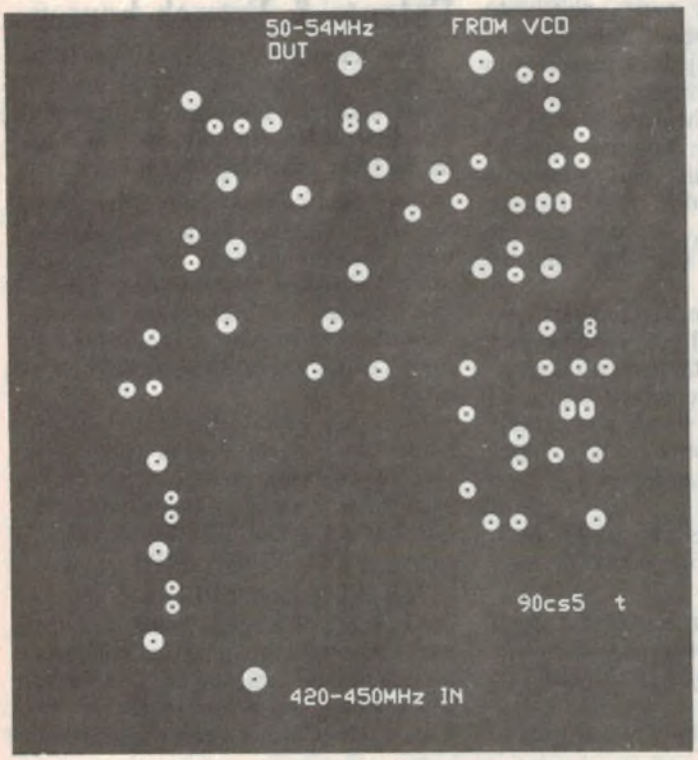


Fig.3: Here is the corrected ground-plane pattern for the 432MHz converter PCB, as discussed above. This should be used to replace that published on page 120 of the June issue.

6M NBFM RECEIVER (January/March 1990): In the PCB overlay on page 85 of the March article, the lower end of capacitor C1 and the upper end (–) of C19 should both be marked with a black dot to indicate a connection to the ground plane copper. Also the component directly between coil L3 and IC3 should be marked C3, not R3, while the resistor between C14 and C17 should be marked R16, not R22.

The PCB pattern also has a small error. The ground plane copper should be relieved around the anode end of diode D4, which connects to R10, C23 and pin 13 of IC3. A small drill (approximately 3mm) should be used to remove a small area of copper from the ground plane copper before mounting D4, to prevent accidental grounding. Neither end of D4 connects to the ground plane.

144MHZ CONVERTER (May 1990): On the top (groundplane) copper layer of the PCB, the track coming from pin 20 of IC11 should connect to pin 5 of IC7 – the copper should not be relieved around this pin.

In the circuit schematic, the 1.8pF coupling capacitor between L1 and L2 should be marked C1. Also VC6 is a 40pF trimmer.

The parts list should call for only one 330 ohm 1/4W resistor, but two 10k 1/4W resistors.

In the overlay diagram on page 88, C17 and C23 should have polarity markings shown. The positive side of C17 connects to pin 16 of IC9, while the positive side of C23 connects to R20. Note that the black dots on the overlay diagram indicate where IC pins and component leads connect to both top and bottom copper layers.

Answer to last month's What??

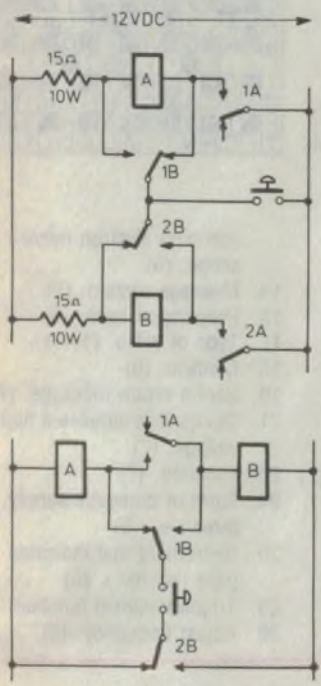
The answer to last month's What?? is 30 ohms and 70 ohms. To solve the problem, a quadratic equation is derived from the expressions: (a) R1 + R2 = 100 and (b) (R1R2)/(R1+R2) = 21 ohms. From these, R2 equals 100-R1, which can be substituted into (b). This gives, after simplification and rearranging, the quadratic equation of: $R1^2 - 100R1 + 2100 = 0$. Solving for R1 gives 30, leaving 70 for R2.

NOTES & ERRATA *Continued*

COMPUTER NEWS & PRODUCTS (June 1990): The Labcard PCL-718 described on page 54 is not available from Control Dynamics, but from Priority Electronics of Suite 7, 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266.

Apologies:

Did anyone spot my deliberate mistake on page 157 of June's Information Centre. Seriously, just how it happened, is a complete mystery. I plead 'temporary insanity', brought on by overwork, and my face is a very bright shade of red. But I'm not on my own – guess who has to do the final check of finished copy. Below is the diagram right way round. My apologies to all the very confused *EA* readers.
(Milli - Production Ed.)



50 and 25 years ago..

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

August 1940

Panoramic Reception:

'Panoramic reception' is a name given to a newly devised method of receiving many stations simultaneously, by its inventor, Dr Marcel Wallace, of New York. The system is so simple that most engineers who have seen it demonstrated wonder why it has not been put into practice long before this.

The first announcement published in *Electronics* was printed in July 1938, page 36. Since that time more complete apparatus has been built and a demonstration of the system has been made to officials of the Civil Aeronautics Authority at the Indianapolis Airport, to show its effectiveness as a radio range beacon for aircraft.

Essentially, panoramic reception is accomplished by observing radio signals on the screen of a cathode-ray oscilloscope. The receiver is a conventional superheterodyne in every respect except that the circuits of the oscillator and antenna are tuned continuously from one end of the band to the other at a rate of about 60 times per second.

The receiver thus sweeps past the signals present on the band and registers an audio output voltage as each signal is encountered. The output is applied to the vertical deflection plates of an oscilloscope. The horizontal sweep frequency of the oscilloscope is controlled so that it is synchronous with the 60 per second tuning cycle. Hence each station on the band registers as a stationary vertical deflection of inverted-V shape.

August 1965

Long-distance instant copy:

LDX is a system for high-speed transmission of line copy that electronically sends a document across a corridor, or across a continent. In seconds, a scanner is able to send to a printer, anything written, typed, sketched or printed. The link between these two components is a broadband transmission line (microwave channel, coaxial cable or special telephone lines).

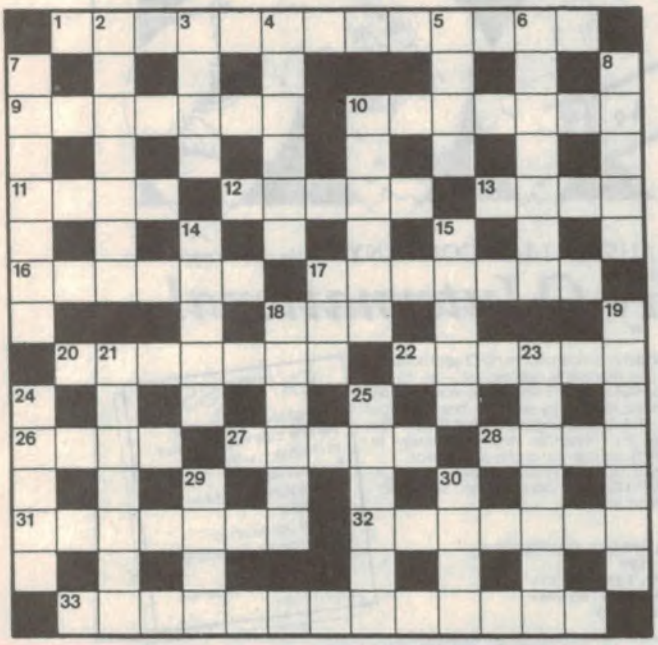
The original document remains with the sender while the device converts an image of the document into electrical impulses and transmits them thousands of miles away or across town to a receiver.

The system is a combination of optics, electronics and electrostatics. A cathode-ray tube in the scanning unit sweeps across the original document. A photo-multiplier converts the light from the scanned page into electrical signals that are then sent via the broadband link to the printer unit which can be thousands of miles away. The received signals are fed to another cathode-ray tube which 'redraws' the image on a selenium coated drum.

EA CROSSWORD

Across

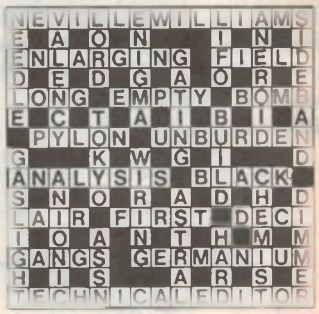
1. Secondary power source. (4-2, 7)
9. Those who copy tapes. (7)
10. Again bring to a focal point. (7)
11. Stuff your memory! (4)
12. Carrier of signals. (5)
13. Insulating mineral. (4)
16. One who checks. (6)
17. Device giving more accuracy to readings. (7)
18. Part of the electromagnetic spectrum. (1,1,1)
20. Resists. (7)
22. Site of stored LP data. (6)
26. Filter type: ---- pass. (4)
27. Full of bright energy. (5)
28. Make a zone secure. (4)
31. Mention details required. (7)
32. What 5 down can do for you. (7)
33. Device used as a voltage controller. (13)



Down

2. Components of radio systems. (7)
3. Sets for EA projects. (4)
4. Unit of pressure. (6)
5. Acronym for tertiary institution. (4)
6. Respond to radio signals. (7)
7. Quality of matter that prevents electromagnetic wave propagation. (7)
8. Determine mineral content. (5)
10. 3D effect, as seen with scanning electron microscope. (6)
14. Message system. (5)
15. Property of neon. (5)
17. Type of video. (1,1,1)
18. Confirm. (6)
19. Sent a return message. (7)
21. Device that induces a high voltage. (7)
23. Function. (7)
24. Form of domestic supply, three ----. (5)
25. Instrument that indicates pace (abbrev.). (6)
29. Trigonometrical function. (7)
30. Adjust frequency. (4)

JULY SOLUTION



EA with ETI marketplace

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AUDIO — TV — VIDEO — REPAIR BUSINESS: For sale — $40,000. (02) 664-1804.

HF BASE ANTENNA HELICAL DIPOLE: 3.85, 7.485, 11.021, 15-.713 MHz. Base mount two 3.8m elements pen band, $750. Phone (057) 82-1166.

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Silicon Valley NEWSLETTER

Motorola, IBM launch radio data network

In a joint announcement, Motorola and IBM have built a huge radio-based network that will allow users of portable, laptop and hand-held computers to tap into their office systems from nearly anywhere in the United States.

Using the service, a field service repairman can record data about a particular job into the company's central computer, and check the availability of certain parts in the company's inventory. In return, the office can send the serviceman information on his next call.

Besides enhancing communications between computers used by workers in the field or on trips, the network could mean a huge boost to the field of telecommuting and allow vastly more workers to work at home at least some of the time.

"We are going to enable workers access to data they have nevery had before," said IBM's Jack Blumenstein, who was named president of the joint venture which is called 'Ardis.'

The service began operation in April and competes directly with cellular telephone services which enable computer users on the road to communicate with their office by hooking a modem or fax to their cellular phone. IBM and Motorola believe their system is better suited for computer users because the computer remains on-line with the central system at all times.

While exact prices still remain to be set, the service is expected to cost between $100 and $150 per month per terminal. Motorola already sells terminals for its cellular phones that can also be used for the Ardis system. IBM has developed a terminal of its own but would not say when, or if it will bring the product to market.

National sues Schlumberger over Fairchild sale

Much of National Semiconductor's financial problems of the past two years have been blamed on the Fairchild operations it acquired from Schlumberg in 1987 for US$125 million. Now National claims that price was too high, and has filed a $20 million lawsuit against Schlumberger.

In the suit, National accuses Schlumberger of misleading it about the value of Fairchild's assets. At the beginning of the negotiations, Schlumberger, according to National, deliberately undervalued Fairchild's net worth. Towards the completion of the acquisition talks, Schlumberger showed that Fairchild's value had increased substantially and National found itself paying US$14 million more than it originally had agreed on.

Now National wants its money back, plus damages and legal fees.

Siliconix talks about settlement

Siliconix, the Santa Clara-based power semiconductor maker which filed for bankruptcy recently, has entered into direct negotiations with International Rectifier.

Siliconix filed for Chapter 11 immediately after it lost a key patent infringement lawsuit and was ordered to pay IR US$4 million in past royalties.

Reportedly, Siliconix will try to negotiate the terms of payments to IR as well as a licence agreement that would enable the company to continue to make and sell products that incorporate the IR patents.

The unfavourable judgement was but the latest blow to Siliconix, which has fallen on hard times after recording the longest string of profitable quarters (more than 144) in US high-tech industry history.

Japan avoids 'Super 301' list

A rush of trade agreements, coupled with a series of recent foreign purchase commitments by a number of highly visible Japanese conglomerates, and various government promises to change and abolish trade barriers have paid off in a big way for Japan. US trade representation Carla Hills said Japan would not be placed on this year's 'Super 301' list of countries engaged in unfair trading practices.

The announcement was sharply criticised by a number of high-ranking members of Congress. Previously, the Semiconductor Industry Association had petitioned the Bush Administration to place Japan on the list, for failing to live up to the 1986 US-Japanese Semiconductor Trade Agreement.

Hills told the powerful Senate Finance Committee that the Japanese have been "moving further in lowering trade barriers to US products than other countries in the past year."

Senator Lloyd Benson, chairman of the panel, however said the failure to name Japan as an unfair trading partner could "poison the well for Congressional approval" of future trade agreements, including one being drafted with the Soviet Union.

Last year, Japan was cited on the Super 301 list for unfair trade in the areas of telecommunications, supercomputing, satellites, and wood products. 301 citings set in motion a process by which the offending country has only one year to negotiate an end to the unfair trade practice, or face automatic sanctions.

Bush drops high tech export barrier

In a dramatic overhaul of Cold War East-West trade policies, the Bush administration announced it is dropping trade bans on the sale of a broad variety of high-technology products to the Soviet Union and other Eastern European countries.

The decision will open the door for US computer, telecommunications and machine tool firms to sell hundreds of millions of dollars worth of products into markets that were previously closed or severely restricted.

The new policies will eliminate or vastly reduce restrictions on more than a third of some 120 product categories. Restrictions on some 30 product groups will be scrapped altogether. "The cur-

rent lists are too long, redundant, and contain items that are not strategically critical to US interests," said White House spokesman Marlin Fitzwater in announcing the Administration's decision, adding the changes would be presented to COCOM members at the meeting in June.

Among the products that will be completely decontrolled are virtually all personal computers from companies such as Apple, IBM, Compaq, and others.

Until now, US firms were forebidden to sell computers capable of speeds exceeding 78 megabits per second. The new rules upgrade that level to around 275 megabits.

Maxtor buys Miniscribe

San Jose-based disk drive maker Maxtor has become the industry's second largest player following the purchase of Miniscribe, whose assets were auctioned off by the Bankruptcy Court.

Maxtor offered to pay US$46 million in cash and stock for all the assets and liabilities of Miniscribe, a leading producer of hard disk drives for personal computers. With the Miniscribe operations, Maxtor will become a company with sales of just under US$1 billion, second only to Seagate Technology of Scotts Valley. More important, the new Maxtor will be able to offer customers a full line of data storage products, ranging from low-capacity entry-level PC drives to high-end engineering workstation storage systems.

The move will also put Maxtor in direct competition with both Seagate and Connor Peripherals of San Jose, another leading supplier of personal computer disk drives. It also means the disk drive business will be an almost all Silicon-Valley affair, with the five largest vendors all located in the Valley.

Soviets to build 'Siliconvalleygrad'

The Soviet Union has always liked Silicon Valley – mostly as a source of much of its electronics technology. Along the way, the Soviets also have come to recognise the special circumstances that have allowed this area to become such a fertile ground for high-tech corporate development.

Now the USSR wants a Silicon Valley of its own, and has hired the San Franciso-based engineering firm of Bechtel to help create it.

The Soviets have designated an existing government research laboratory at Troitsh, 20 miles south-west of Moscow, as the centre of what it hopes will become a sprawling high-technology industrial area that will breed a new generation of Soviet-made computers and other high-tech products.

In the first phase of the contract, Bechtel will conduct a feasibility study. Bechtel will look at the success and failure of other Silicon Valley clones around the world and recommend the first steps the Soviets should take to make their effort successful.

Digital Research Inc lost a 'big one' in 1980, when IBM chose rival Microsoft to develop the operating system for its PC. After that its fortunes waned, but since 1987 it has made a strong comeback under the guidance of CEO Dick Williams, a former IBM veteran. Last year the Monterey-based company made a healthy profit on sales of US$36.5 million.

Japanese lead in patent 'top 10'

Japan has been outspending US companies in research and development for more than a decade. So it should not have come as a big surprise when the US Patent Office announced that more Japanese than American firms ranked among the 10 companies with the most new patents, in 1989.

Five of the top 10 new patent holders last year were Japanese, with the largest number of patents (1053) by any firm held by Hitachi – the fourth consecutive year Hitachi has taken the top spot.

Hitachi was followed by Toshiba with 961 patents, Canon with 949, and Fuji photo film with 884. The highest ranking US company was General Electric. GE held the top spot between 1969 and 1986 when Hitachi took over.

Others on the Patent top 10 were Mitsubishi in 6th place with 767 patents, US Philips in 8th with 745, IBM 9th with 623 and Kodak 10th with 589.

Sony making TV tubes in Pittsburgh

In a move that could ultimately lead to the production of HDTV sets in the United States, Sony has announced plans to remodel a vacated Volkswagen factory near Pittsburgh, to produce state-of-the-art television tubes.

The plant, where Volkswagen produced its Rabbit model for the American market, was closed in 1988 after sales of the car had fallen off sharply.

Sony will employ some 1000 people at the facility which is located in New Santon, 20 miles southeast of Pittsburgh. Reportedly, Pennsylvania has offered Sony as much as $28 million in loans and other incentives.

The New Santon facility will be Sony's third US television facility. It already operates a tube manufacturing and television assembly facility in San Diego. The company also maintains a research operation in San Jose, where it is in the process of developing HDTV-related technologies.

Apple's 'leak stopper' being tailed

In the latest sage of Apple's efforts to catch employees who routinely leak product information and other secrets to the outside world, the executive in charge of the spy eradication program is himself being investigated. And he doesn't like it at all!

Edward Stead, Apple's vice president of law and general counsel, said he has filed a lawsuit against a Silicon Valley private detective agency seeking a restriction order that would keep the firm's agents literally off his back. On several occasions, Stead said his car had been followed by agents of the detective bureau as he left work at Apple.

Stead said he has no idea who hired the detective agency of Joseph Melodia, or why. To date, Melodia has refused to identify who hired his company to investigate Stead.

One thing appears certain: Stead is not being investigated by Apple, which has denied having anything to do with the investigation of Stead. A letter of denial from Apple president John Scully was included in Stead's court documents.

Solid State Update

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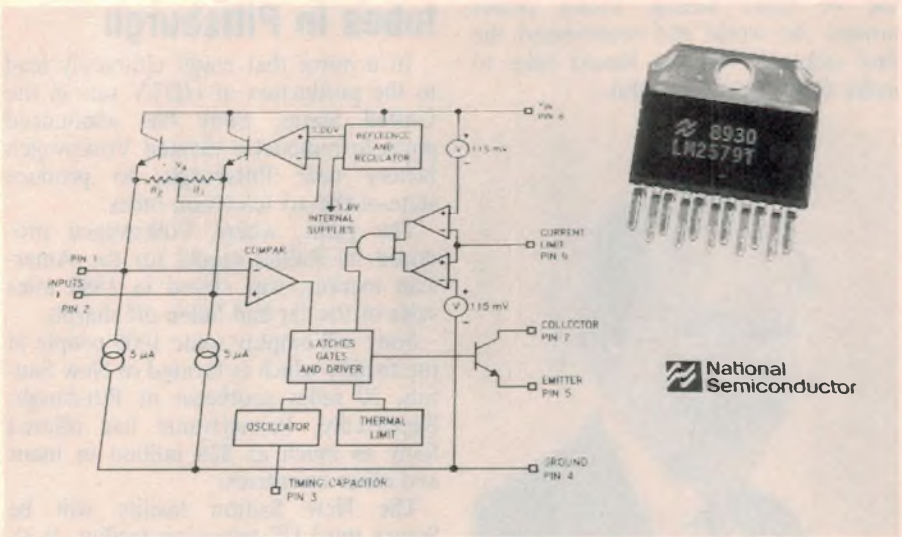

Switching regulators up to 3A

National Semiconductor has introduced the LM2579, a 3-amp switching regulator that can step-up, step-down or invert voltages. The device is the latest member of the company's switching regulator family, which includes the LM2575 step-down switching regulator.

The LM2579 is a very flexible part, with a comparator input stage that simplifies circuit design. The comparator has separate pins for both the inverting and non-inverting inputs and an internal 1.0-volt reference connected to each input.

A single external capacitor is used to set the oscillator frequency of the switching regulator, which can cover a broad range from less than 1Hz to 100kHz.

With added components, additional functions can easily be added, such as under-voltage lockout, remote shutdown and parallel operation of more than one device.

Further information from National Semiconductor distributors.

Cache address comparators

Two cache address comparator chips (cache tags) that can help designers streamline custom cache memories in high-performance systems are available now from Texas Instruments. The industry's deepest cache tags, the new 16K x 5-bit devices are the latest in TI's line of processor-independent cache building blocks. Designers can use these products to enhance the performance of 80386, 80486, 68030 and 68040 based systems operating at or beyond 20MHz.

With the capacity to store 16,384 cache memory addresses and address-to-match delays of 20 and 18 nanoseconds respectively, the new SN74ACT2613 and SN74ACT2164 are suitable for 80486-based systems where space on the motherboard is already at a premium.

For further information contact your nearest Texas Instruments office.

Power hybrids

Allen-Bradley has introduced a new range of power hybrids, designed to dissipate greater than five watts per square inch and combine one or more technologies to produce compact and efficient devices.

The circuits vary from a single high power switch to complete three phase drives including six switches, output driver and rectifier bridge.

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For further information contact Allen-Bradley, Electronic Components Division, 56-60 Parramatta Road, Lidcombe 2141 or phone (02) 648 2652.

16-bit A/D converters

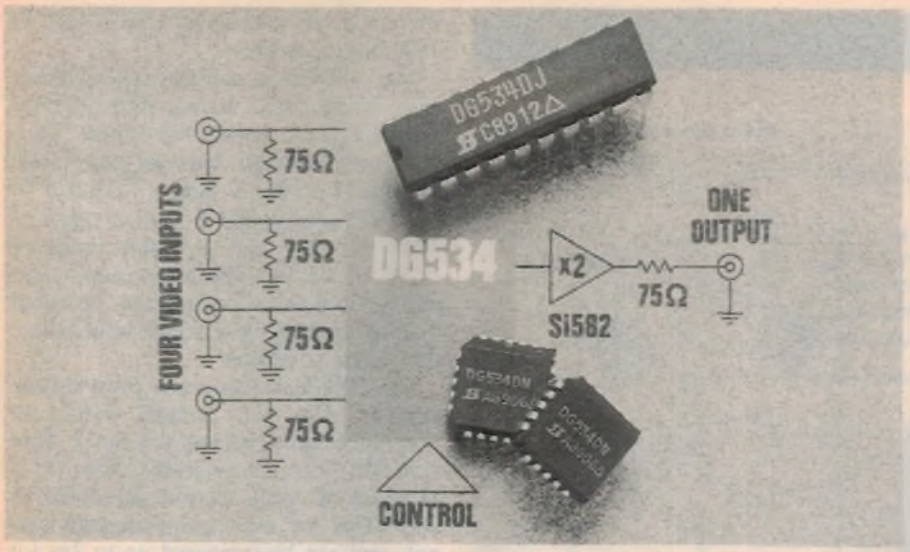
The MN6290 series of low-distortion, 16-bit, sampling, A/D converters offers a combination of resolving power, conversion speed, low noise, and low harmonic distortion.

The A/D's are packaged in small, 32-pin, double-wide DIP's and have internal track-hold (T/H) amplifiers that enable them to accurately sample and digitise 10kHz full-scale input signals at rates up to 20kHz.

Each device is fully FFT (fast fourier transform) tested, using contemporary DSP technology and guarantees up to 84dB signal-to-noise ratio and up to –88dB harmonics and spurious noise.

A high-impedance (5M) input buffer isolates the T/H from its signal source, and the T/H's operational mode is internally controlled by the A/D's status line. Users need only supply start-convert pulses at the desired sampling rate.

For further information contact Priority Electronics, 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266.



Wideband/video multiplexer

The DG534 is the latest addition to the Siliconix family of wideband/video ICs. The new IC is a logic selectable four-channel or dual two-channel multiplexer that is used to select one of four RF or video signals to a common output.

Manufactured with the silicon-gate D/CMOS process, the DG534's wideband DMOS switches are connected to a 'T' configuration, and the ground pins are adjacent to all input and output signal pins. These design features minimise crosstalk and optimise off-isolation. When combined with the D/CMOS characteristics of low on-resistance and low drain capacitance (8pF maximum), these features contribute to the device's vastly superior performance.

The DG534 is available in 20-pin plastic DIPs for through-hole applications and small 20-pin J-leaded plastic chip carriers (PLCC) for surface-mount assembly.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 748 4066.

Upgraded voltage references

Maxim has introduced the MAX674 and MAX675 voltage references – low cost pin compatible upgrades for the popular REF01 and REF02.

The MAX674 and MAX675 feature enhanced drift specifications of 12ppm/°C, initial accuracy of +/–0.15%, and load regulation of 20ppm/mA.

An output adjustment trim terminal further refines the precision, allowing system designers to trim system errors by setting the output to a voltage other than +10V or +5V. The trim adjustment is a minimum of +/–300mV on the MAX674 and +/–150mV on the MAX675.

The MAX675 has a temperature voltage output that supplies a voltage proportional to the absolute temperature. This feature is especially useful for designing precision temperature transducers. At 1.4mA max, the quiescent current on the MAX674 and MAX675 is minimal, making these references ideal for systems where power conservation is critical.

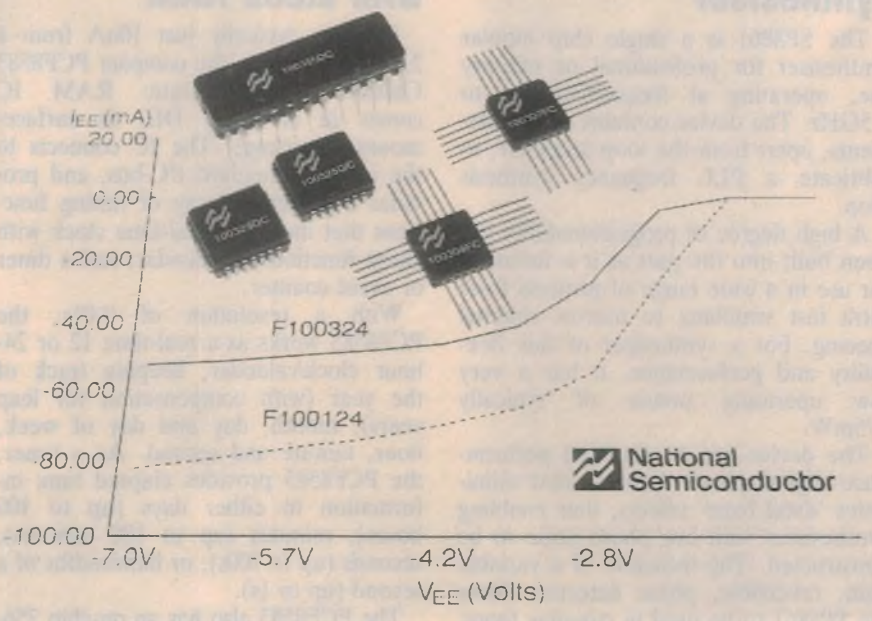
For further information contact Veltek, 5 King Street, Rockdale 2216 or phone (02) 5199 1900.

Lower power, easy to use ECL

Responding to increasing demand for ECL logic that is as easy to use as TTL logic, National Semiconductor has introduced its F100K 300 series ECL logic family.

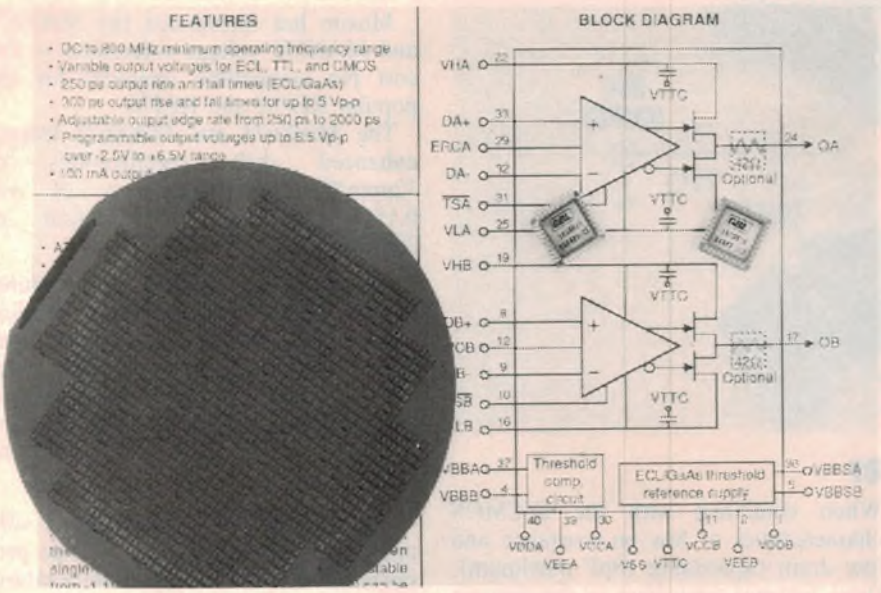
F100K 300 series devices help designers by simplifying the upgrade of their existing ECL designs. Since F100K 300 series parts are plug-in replacements for 100K devices, a simple switch can reduce system power consumption by 30-50% to levels previously reserved for TTL-based designs.

Compatible with industry-standard 100K, 10K and 10KH ECL logic families, the F100K 300 series has the same 750ps switching as its fastest counterparts, but draws only half the amount of power. In addition, it offers the temperature compensation of 100K and the wide supply voltage range of 10KH. Other unique features include minimised skew and small footprint, low-cost PCC packaging.



Performance driven application such as super-minicomputers, servers, vector processors, fibre-optic and satellite communications, instrumentation, graphics/imaging, and radar systems need no longer suffer the noise and bandwidth bottleneck of TTL-based designs.

For further information contact your nearest National Semiconductor office.



Monolithic 800MHz dual pin driver

With DC to 800MHz operation and up to 6.5V peak to peak output swing, Gigabit's 16G061A dual high speed pin driver is intended for high performance test systems designed to test current and future generations of ECL, GaAs, CMOS and TTL integrated circuits.

ATE manufacturers need state of the art pin drivers with extremely fast rise and fall times, three-state output capability, and wide output swing. The monolithic 16G061A pin driver has all these key features and offers two drivers in one package at US$76 each in 1000 unit quantities.

The 16G061A contains two electrically independent drivers with differential ECL/GaAs compatible inputs. Outputs are switched between the levels provided on the V high (VH) and V low (VL) inputs with a V high range of –1.1V to 6.5V and a V low range of –2.5V to +1.5V. Maximum output amplitude is 6.5V. Controls are provided to force outputs into a high-impedance, three-state condition.

The 16G061A features a continuously variable edge rate control (ERC) to vary the output rise and fall times. Rise and fall times are typically 250ps for a 1V peak to peak output (GaAs/ECL) and 300ps for a 5V peak to peak output, and can be increased up to 2ns for a 5V peak to peak output. Propagation delay is 700ps for fast edge rates and 1.5ns for slow edge rates signals. Output current drive capability is 100mA.

Applications include semiconductor ATE pin electronics, differential line receiver, switch driver, CRT preamplifier, level comparator and translator, general purpose driver and precision pulse generator.

For further information contact Gigabit Logic, 1908 Oak Terrace Lane, Newbury Park, CA 91320 or phone (805) 499 0610.

1.5GHz frequency synthesiser

The SP8861 is a single chip bipolar synthesiser for professional or military use, operating at frequencies up to 1.5GHz. The device contains all the elements, apart from the loop amplifier, to fabricate a PLL frequency synthesis loop.

A high degree of programmability has been built into the part as it is intended for use in a wide range of projects from ultra fast switching to narrow channel spacing. For a synthesiser of this flexibility and performance, it has a very low operating power of typically 175mW.

The device has a very high performance digital phase detector that eliminates 'dead band' effects, thus enabling synthesisers with low phase noise to be constructed. The inclusion of a variable gain, reversible, phase detector allows the SP8861 to be used in complex loops such as those involving mixing down from microwave frequencies.

For further information contact Plessey Semiconductors, Christina Road, Villawood 2163 or phone (02) 72 0133.

Clock-timer IC with static RAM

Drawing typically just 10uA from a 2.5 to 6V supply, the compact PCF8583 CMOS clock/timer/static RAM IC comes in an 8-pin DIL or surface-mounted package. The IC connects to the industry-standard I^2C-bus, and provides a powerful array of timing functions that include a real-time clock with alarm functions, a calendar, and a timer or event counter.

With a resolution of 0.01s, the PCF8583 works as a real-time 12 or 24-hour clock/calendar, keeping track of the year (with compensation for leap years), month, day and day of week, hour, minute and second. As a timer, the PCF8583 provides elapsed time information in either days (up to 100 hours), minutes (up to 100 minutes), seconds (up to 100s), or hundredths of a second (up to 1s).

The PCF8583 also has an on-chip 256-byte static RAM that retains data even when the supply falls to 1V. This can store alarm, status or time information as well as telephone numbers, access codes, and other application-related information.

Timing for the PCF8583 is derived from a 32kHz crystal or externally applied 50Hz signal.

For further information contact Philips Components, 11 Waltham Street, Artarmon 2064 or phone (02) 439 3322.

Solid state lamps

Sharp has released two solid state lamps, with a hood in a totally waterproof encapsulation. These combine super-luminosity red LEDs and high-luminosity yellow-green LEDs to provide three radiation colours (red, yellow-green and orange).

The LT6600 has a radiation size of 26mm and consists of five red and eight yellow-green LEDs to provide a total intensity of 1800mcd (red) and 1000mcd (yellow-green).

The LT6701 has a radiation size of 52mm and consists of 20 red and 27 yellow-green LEDs to provide a total intensity of 7000mcd (red) and 4000mcd (yellow-green).

Further details are available from Manuco Electronics, 21 Agnes Street, Jolimont 3002 or phone (03) 650 3977.

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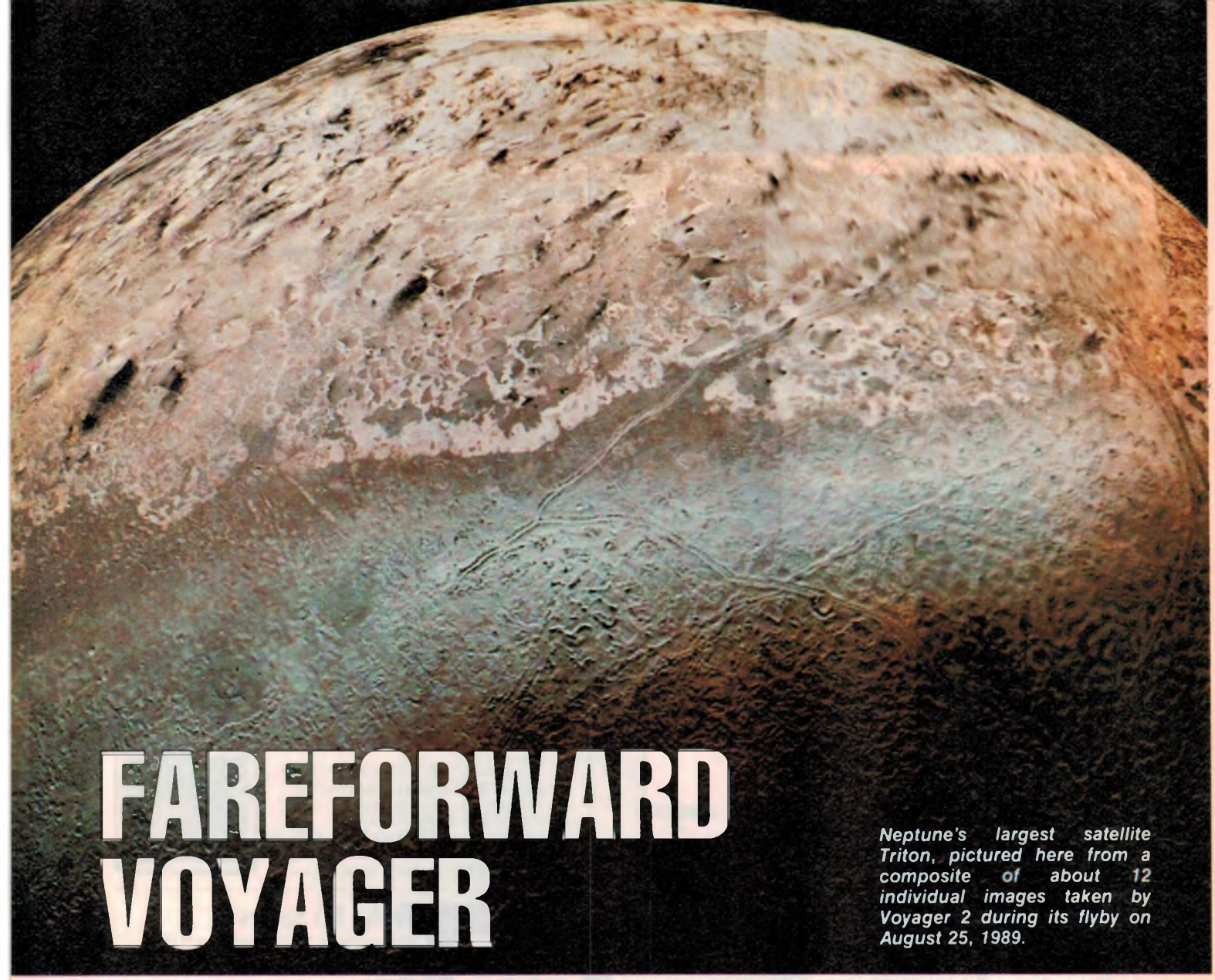


FAREFORWARD VOYAGER

Neptune's largest satellite Triton, pictured here from a composite of about 12 individual images taken by Voyager 2 during its flyby on August 25, 1989.

Kathryn Doolan takes us on the 'Grand Tour' of Voyager's amazing journey to Jupiter, Saturn, Uranus and Neptune, planned to culminate in the spacecraft's arrival at the boundary of our known solar system. There, it will turn to face the Sun to take a photograph of the solar system, before continuing on its unending path.

Late August 1989, saw the culmination of one of history's greatest journeys of exploration. Defying the odds, and its design life of five years, the spacecraft *Voyager 2*, encountered the planet Neptune at close range for the first time. After a 12 year journey, *Voyager 2* flew to within 4000 kilometres of Neptune's cloudtops, giving scientists all over the world their first comprehensive look at the giant gas planet.

The idea of a 'Grand Tour' of the outer planets first came up in the mid 1960's. Scientists and engineers at the Jet Propulsion Laboratory (JPL) in Pasadena, California, had determined that there would be an opportunity for the Tour in 1977, with the alignment of the four outer planets – Jupiter, Saturn, Uranus and Neptune. This alignment occurs only every 177 years. Using what was called a 'sling shot trajectory', a spacecraft could use the gravity of one planet to 'sling shot' itself to the next, saving on energy and time. A conventional spacecraft fuelled by normal means would take much longer to reach its destination.

In 1969, NASA began detailed planning for the 'Tour'. The first idea was to launch two spacecraft to visit and observe Jupiter and Saturn, and to drop probes down into their atmospheres (similar to the journey of Galileo, launched in October 1989). One of the spacecraft would visit Jupiter, Saturn and Pluto and the second would visit Jupiter, Uranus and Neptune. The estimated cost was US$ 750 million – a large sum of money to post-Apollo NASA – so not surprisingly, this version of the 'Tour' was cancelled in 1972.

NASA planners then came up with an abbreviated schedule. Two spacecraft would use the gravitational slingshot to visit only Jupiter and Saturn. The revised cost was US$ 250 million, a sum found to be acceptable, and on July

1972, the Mariner/Jupiter/Saturn program began, with a proposed launch date of August 1977.

The spacecraft for the journey, designed by engineers at JPL, was christened *Voyager* in 1975. Both spacecraft were state of the art and incorporated many new features. Each of the two *Voyagers* weigh 825kg and stand 3.7m tall. When the spacecraft's two booms are extended, *Voyager's* width is 17.2m. It is powered by Radioisotope Thermoelectric Generators (RTGs), which convert the heat released by the decay of Plutonium 238 to electricity. The minimum total power available to *Voyager* ranges from 423 watts at launch in 1977 to 370 watts at Neptune.

Both spacecraft have a dish antenna 3.7m in diameter, which remains continuously pointed at Earth to receive and send back information. Two radio receivers, one main and one backup, transmit material using 22 watts of power.

Each of the spacecraft carries ten scientific instruments, including narrow and wide angle television cameras, spectrometers, detectors, magnetometers and radiometers, and use the radio as an eleventh. Most of these instruments are mounted on a 'scan platform', so experiments can be carried out without having to swivel the spacecraft around continuously.

Voyager 2 was launched into space aboard a Titan 'Centaur' rocket from the Kennedy Space Centre on August 20 1977, and immediately ran into the first of many technical problems. Ground controllers at JPL received a signal from *Voyager 2* that the boom which held the scan platform had not been fully extended. Without the boom deploying properly, *Voyager* would be unable to use instruments on the platform, jeopardising the mission's scientific purposes.

Luckily, however, scientists and engineers at JPL found that the spacecraft sensors were incorrect and the boom had in fact deployed. On September 5 1977, *Voyager 1* was launched though it almost did not leave Earth's orbit due to a malfunctioning rocket. The problem was solved, and it eventually arrived at Jupiter in early March 1979, before *Voyager 2*.

Among the discoveries made were a ring system around the planet and new data about its moons and atmospheric formations. *Voyager 2* arrived four months later and was witness to an incredible discovery concerning the moon Io. When *Voyager 1* had observed the planet, scientists had been astounded to discover an active volcano system with several volcaneos erupting at once. *Voyager 2* observed that six of those volcanoes were still erupting, at the same furious pace as they had been four months earlier.

The next stop for *Voyager 1* was Saturn, in November 1980. It was found that Saturn was surrounded by thousands of rings, comprising mainly rock and ice. Other highlights of the stop included observation of the moon Titan, the only moon in the solar system to have an atmosphere comprising nitrogen and hydrocarbons – essential to life. After this encounter, *Voyager 1* started on its journey to the edge of the Solar System, and is expected to reach there early next century.

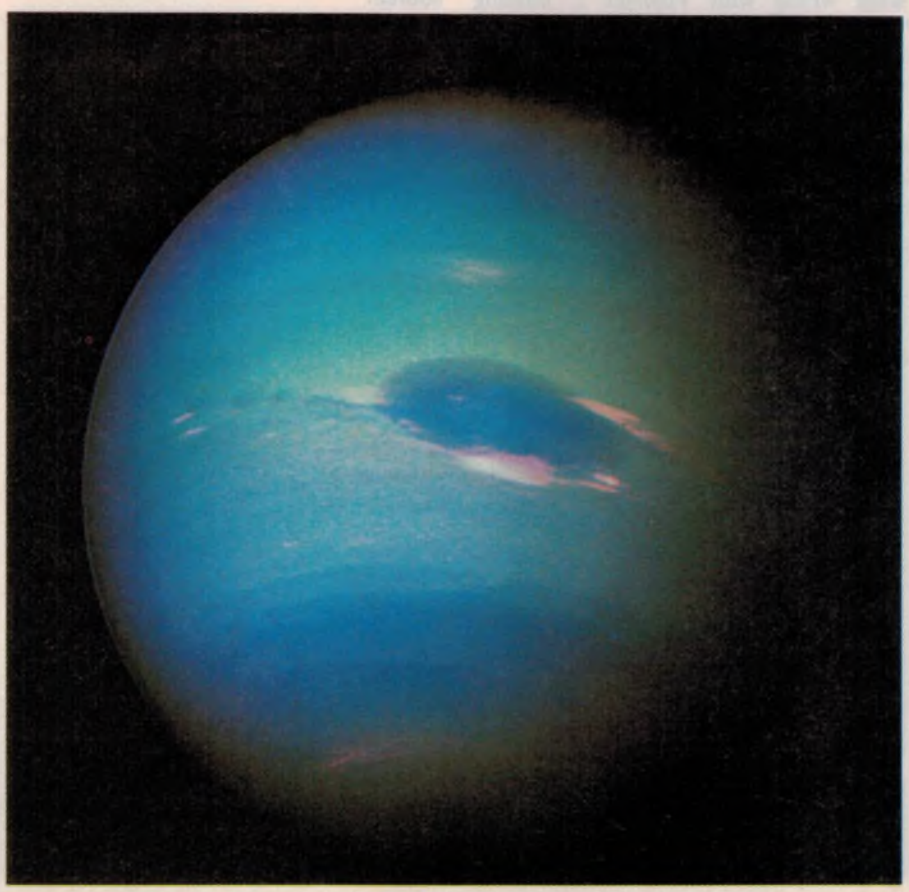
Voyager 2 encountered Saturn in August 1981 – almost its final stop, as it turned out. After making its closest approach to Saturn and travelling behind the planet, *Voyager's* scan platform froze, limiting its movement and making it impossible for scientists to point the instrument at the planet. Eventually, however, engineers at JPL were able to start the platform again – at a lower speed, but enabling observations at Uranus to take place when *Voyager 2* arrived there in January 1986.

Uranus was a disappointment to the scientists as it was bland, with no interesting surface features. The focal point of *Voyager's* Uranus flyby was the moon Miranda, described as 'the main bizarre object in the solar system' because of its incredible mishmash of geological activity and contradictions.

Even as the Uranus encounter was taking place, extensive plans were being made for the Neptune encounter in August 1989. Approval and extra money for the flyby were granted and JPL scientists started to wrestle with some unique problems, not least an improved communications system.

For all its planetary missions, JPL uses the 'deep space network', a series of radio telescopes deployed at strategic locations around the world, to send and receive information from spacecraft. The three DSN stations are located near Madrid, Spain; Goldstone, California; and Tidbinbilla in the ACT (which was going to play an essential role in the Neptune flyby).

The three main antennae at the DSN



Neptune itself, in a false colour image processed from the UV, violet and green filtered images. This differentiates the clouds at different altitudes, by showing them in different colours.

stations each had a diameter of 64 metres, sufficient for communication with *Voyager* until after the Uranus encounter in 1986. In late 1986, construction began at Madrid and Tidbinbilla to extend the main antennae from 64 to 70 metres for the Neptune encounter, and in mid-1988 similar construction started at Goldstone.

Arrangements were also made with the Australian Government to use the CSIRO radio antenna facility at Parkes in NSW, as a backup for the Tidbinbilla facility in case of technical problems or bad weather. Similar arrangements were made to use the 'very large array' (VLA) in New Mexico, a series of 27 radio telescopes normally used for radio astronomy. The Japanese Government also approved the use of its radio telescope, located not far from Tokyo. This setup proved to be a great success and enabled first class data to be returned to Earth.

Because of Neptune's great distance from Earth, it would take signals from the spacecraft four hours and six minutes to arrive here, so if something went wrong with *Voyager 2*, nothing would be able to be done. Engineers consequently programmed the spacecraft to keep on broadcasting if communication with Earth was lost.

The planet Neptune was first observed in 1848. It was the first planet discovered by mathematical calculation, and not through systematic observations of the night sky. Two young mathematicians, working separately and unknown to each other – John Couch Adams, in England and Urbain Jean Joseph Le Verrier, in France – made very similar calculations and are both credited with the planet's discovery. Following the tradition of naming planets after Greek or Roman gods, it was christened Neptune, after the Roman god of the sea.

Neptune, until *Voyager's* recent observations, was always thought to be the twin of Uranus, because of their similar size, colour and distance from the Sun. This has proved to be untrue and in fact, the two planets share few similarities.

Neptune is currently the furthest planet from the Sun (four and a half billion kilometres) and will remain so until 1999. It receives 1000 times less sunlight than Earth does, and approximately two and a quarter times less than Uranus. The two planets have a similar overall temperature, however, so it seems that Neptune must have an internal heat source.

A day on Neptune is approximately 18 hours long and it takes the planet approximately 165 years to make one orbit of the Sun. Before the *Voyager 2* encounter, it was unclear whether Neptune had a ring system; the general consensus was that the planet was surrounded by an incomplete system of rings known as 'ring arcs.'

Neptune, before *Voyager*, had two known moons – Triton, discovered in 1849, and Nereid, discovered in 1948 by astronomer Gerard Kuiper. It was hoped that *Voyager 2* would shed new light on the moons and discover more.

The Neptune encounter period officially began on June 5 1989, 62 days before the closest approach. During those 62 days, known as the observatory period, the spacecraft made continuous observations of the Neptunian system, its imaging cameras monitoring atmospheric motion on the planet and looking for ring arcs and satellites.

Eighteen days before the closest approach, the far encounter phase began with two narrow angle cameras trying to capture the whole planet.

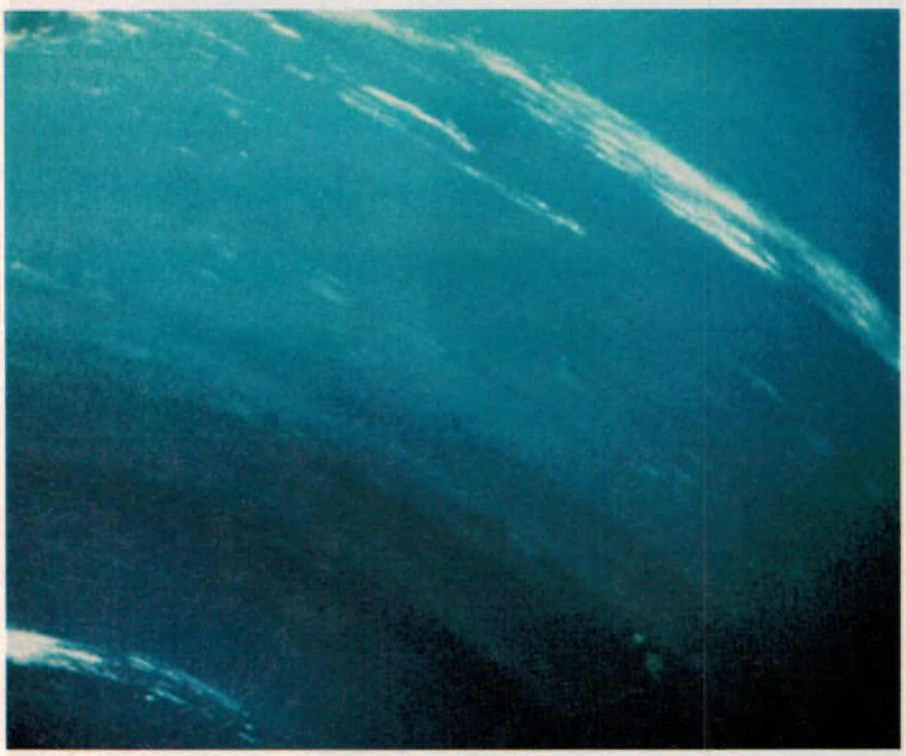
The most important observations of Neptune took place in the five day near encounter phase. During that five days *Voyager* encountered Neptune from a distance of approximately 4850 kilometres.

With the near encounter completed, the post encounter phase took place, with *Voyager* continuing to observe Neptune (especially the dark side of the planet) and starting to send stored data back to Earth.

Early in January 1989, when *Voyager's* images of Neptune were becoming a little clearer to the JPL team, a dark spot was observed, very similar to Jupiter's famed Red Spot. Other early discoveries included confirmation of a ring arc system and dynamic activity in the Neptunian atmosphere.

As *Voyager* closed in on Neptune in mid June, the first of Neptune's new moons was discovered. Christened 1989N, the moon ranges in size from 200 to 600 kilometres in diameter and is orbiting the planet at an approximate distance of 92,700 kilometres from Neptune's cloud tops. Because of N1's relative closeness to Neptune, it cannot be seen from Earth, as the planet's brightness blocks it out.

More moons were discovered in July, as *Voyager* closed in on Neptune at a speed of 1.7 million kilometres per day. The new moons – 1989N2, 1989N3 and 1989N4 – are thought to orbit in the region of the ring arcs. All the new moons are thought to be smaller than N1 and occupy nearly circular and equatorial orbits around Neptune. Scientists are puzzling why all these moons orbit Neptune in one direction, while Triton



A closer view of Neptune, taken using Voyager 2's wide-angle camera when the spacecraft was 590,000km from the surface. This is an image with the correct colour balance.

orbits the other way.

Twelve years almost to the day, *Voyager* arrived at Neptune a mere 20 miles off course after a journey of two billion kilometres. Scientists were stunned by Neptune's magnificent atmospheric activity.

The main feature, nicknamed the 'Great Dark Spot' was thought to be about the size of Earth and, like the Red Spot, a storm that had a life of its own and rotated in the opposite direction to the planet.

Another feature was nicknamed the 'Scooter' – a small wispy cloud that rotates around the planet faster than other clouds. There appears to be a large amount of cloud in the upper atmosphere that, because of their shape and size, scientists equate to cumulus clouds on Earth.

Neptune is racked by the fastest winds measured in the solar system – winds travelling at nearly supersonic speeds, even in Neptune's dense atmosphere. It was also found that Neptune has a magnetic field which is tilted 50° from the planet's rotation axis and is offset 10,000 kilometres from the planet's centre.

Neptune is cloaked by a hazy upper layer (like smog). Under this thick atmosphere, Neptune is thought to have a 'melted' ocean of ice which lies over a rocky core, and a temperature of minus 180°C.

Comprising mainly hydrogen and methane, Neptune was found to have aurorae in its upper atmosphere, and faint radio emissions were recorded by the spacecraft.

Once *Voyager* had made the close encounter and discovered another two moons, 1989N5 and 1989N6, it discovered that instead of only have incomplete ring arcs around it, Neptune also had a system of three complete rings. Both the rings and ring arcs are thought to be made up of small dust particles.

Five hours after the main encounter with Neptune, Triton was encountered and, as spectacular as Neptune was, Triton completely stole the show. Triton is an incredible contradiction of geological activity, which left scientists both ecstatic and stunned. Slightly smaller than our moon, it showed ancient ice volcanoes, quake faults, cliffs, glacier-like terrain and swamps of ice mush methane. The moon has the coldest temperature in the solar system, at minus 245°C, and is the third body in the solar system with a system of volcanoes (the other two are Earth and Jupiter's moon Io).

When images were returned a month after the main flyby, scientists were amazed to see the eruption of a volcano, spewing frozen methane and hydrogen five miles high. Careful examination of Triton's surface showed that there is an abundance of volcanic activity with the surface pockmarked with craters, some of which showed recent activity.

Post encounter activities consisted primarily of observations of Neptune's dark side and the sending back of recorded data to Earth. This phase was completed on October 2.

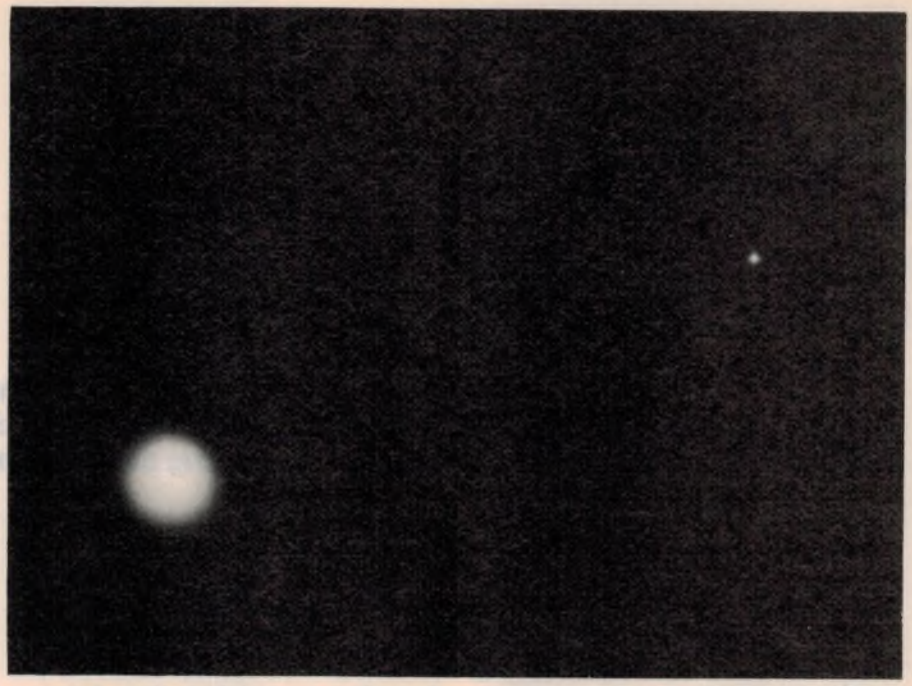
Voyager, now renamed the Voyager Interstellar Mission (VIM), is now well on its way to the boundary of the known solar system. In May, most of its instruments shut down to conserve energy, but not before the spacecraft turned around towards the Sun to take a photograph of the solar system – an image which will surely be spectacular.

Voyager has no set destination, but scientists at JPL have calculated that, if it continued on its present path, it would encounter the star Sirius in the year 296,036 – from a distance of 432 light years.

Expected to run out of fuel by the year 2020, *Voyager 2* can rightfully be called one of the greatest exploration journeys undertaken by man, and long after all of us are gone, it will still be drifting on an unending path.

There has been much written about the *Voyager* spacecraft and their discoveries, summed up by Dr Edward Stone, *Voyager's* chief scientist, in a quote by T.S. Elliot:

"Not farewell, but fareforward, Voyagers".



Neptune and its large moon Triton as pictured by Voyager 2 on May 9, 1988, using the clear and green narrow angle filters. The planet appears bluish-green because methane in the atmosphere absorbs red wavelengths.

Aussie CAD Software Review:

Protel's Schematic V3.3

In previous issues, we've reviewed both the 'top of the range' and 'economy' PCB layout packages from pioneering Tasmanian software firm Protel Technology. Here's a report on the latest version of their matching package for drawing circuit schematics.

by JIM ROWE

Back in the September 1989 issue, you may recall, we published a double review of Protel's 'Autotrax' professional PCB layout package, by Peter Phillips and Mark Cheeseman. Then in the following December issue, we published Tom Moffat's review of the firm's revamped economy PCB layout package, dubbed 'Easytrax'.

Our reviewers found both of these packages very convenient to use, and capable of producing highly professional results. In fact they were so impressed that based on their reactions, we've been using Autotrax in particular, here in the *EA* office ever since, to produce the PCB designs for many of our projects.

As with all CAD packages, there's an inevitable learning curve. Our first PC board designs took rather longer than if we'd used the familiar old tape-and-donut system, but it didn't take too long before we became familiar enough with Autotrax to be able to drive it quickly and efficiently. And we've been very happy with the results.

It's understandable that based on this experience, we were also keen to try out the latest version of Protel's matching Schematic 'capture' package – Version 3.3. Happily an opportunity to do this came a couple of months ago. We've been using it ever since, and some of the products of our trials have already appeared in the magazine. The article that follows is a summary of our experiences and findings to date.

The package

Like the matching PCB design packages, Protel Schematic is designed to run on IBM PC/XT/AT and PS/2 Series machines and close compatibles. It will run on a twin floppy system, but operation is faster and more efficient when it's installed on a hard disk. Similarly best results are achieved with an EGA or VGA colour graphics adapter and matching colour monitor, although it *can* be used with a monochrome adapter/monitor – in fact it's somewhat less dependent upon colour than Autotrax and Easytrax.

A Microsoft or compatible mouse is recommended for faster and more convenient operation, but like the PCB packages Schematic can be used without a mouse if you don't have one. In fact for some operations, the keyboard is almost as convenient as the mouse; more about this later.

Schematic 3.3 will run happily in a system with 640K of conventional memory, but the maximum size of a schematic file is limited to about 200K or so, depending upon the number of TSR's (memory resident utility programs) present. This means that for handling larger schematics, you may need to remove TSR's (like Sidekick, etc).

The package can make *limited* use of LIM 4.0 type EMS (expanded) memory, if this is available – but only for holding its overlays. This gives faster operation, but still doesn't allow handling larger schematic files; the only real way to do this is by breaking them up into separate subsections.

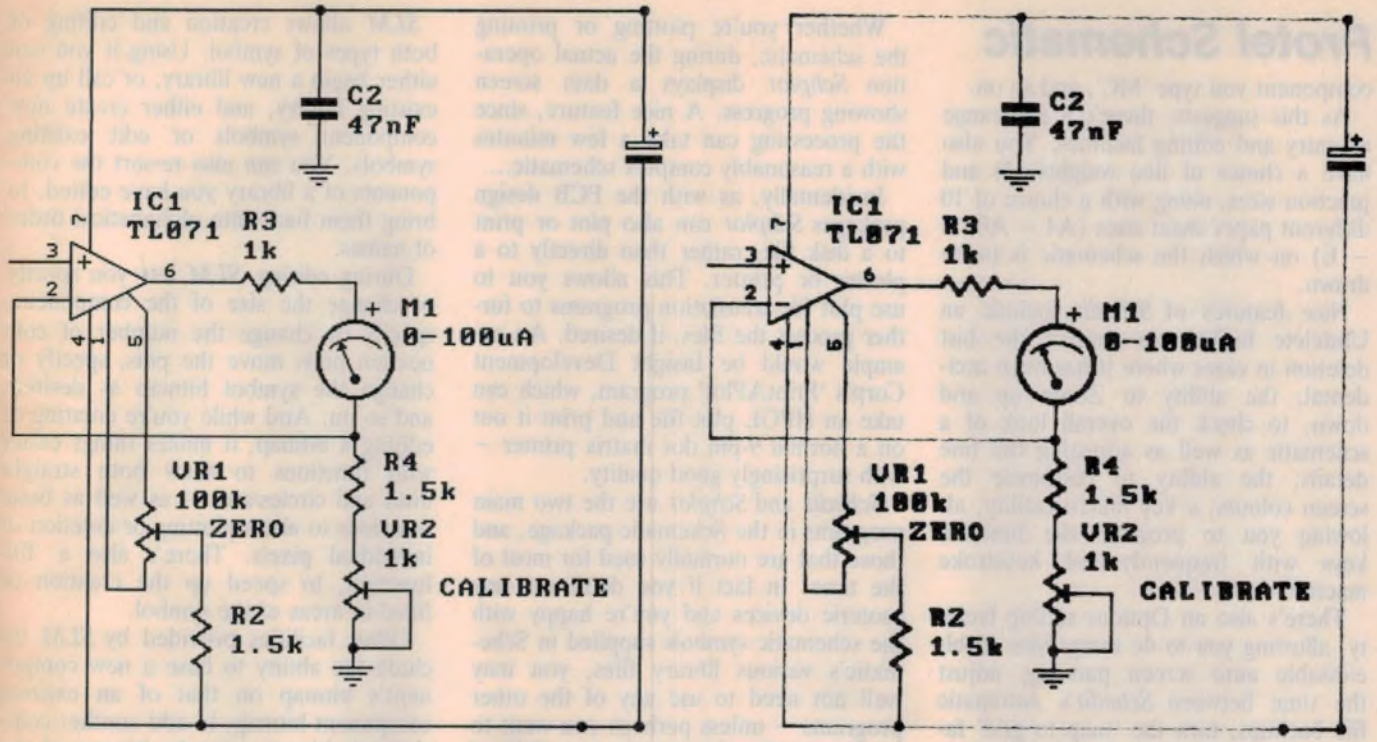
The physical Schematic 3.3 package comes as six 5.25" 360K floppy disks and a ring binder reference manual. Earlier versions included copy protection, and came with a hardware 'dongle' which had to be plugged into one of the parallel printer ports, before the main programs would run. But Protel has now removed the protection, so the dongle is no longer needed.

In terms of software the package consists of seven functionally separate and complementary programs. The main three consist of *Schedit*, the actual schematic entry and editing program; *Schplot*, the program which prints out or plots the resulting schematic files; and *SLM* or 'Schematic Library Manager', a program which lets you modify or create schematic symbol libraries. Then there are four utility programs: *Post*, which processes a schematic file to produce a netlist for PCB routing, a wirelist (presenting the netlist in human-readable form), a report of any errors found in the netlist, and a 'BOM' or bill of materials; *Netcheck*, which can compare two netlists and report any differences; *Nettran*, which can convert a Protel netlist file into other formats (including Racal, Cadnetix, P-CAD, Calay and Computervision); and *Annotate*, which can process a multi-sheet schematic file so that all components are renumbered into consecutive order.

All three of the main programs have a graphical-type user interface, with easy to use pop-down menus. However as with the PCB design programs, they're also designed so that once you're familiar with program operation, you can speed things up considerably by using keyboard 'shorthand'. More about this later, too.

Four of the six disks supplied in the package contain the programs just described, plus device drivers, while the remaining two disks contain some 17 different predesigned schematic symbol 'libraries'. These cover all sorts of things from basic discrete components, through standard op-amps and comparators, TTL and CMOS logic devices, to memory devices and microprocessors. A very wide variety of standard device symbols, in fact – plenty to get almost anyone going, and probably sufficient for even the long-term needs of many users.

As with many of the latest software packages, Schematic 3.3 comes with an



Two samples of the kind of hard-copy output produced by Protel's Schematic V3.3, reproduced here actual size so you can evaluate the resolution. At left is the quality from a TI 'MicroLaser' 300dpi printer; at right that from a Roland DXY-980A plotter. In each case the main factor limiting resolution appears to be that of the software package itself, which is fixed at about 100dpi for the bit-mapped component symbols.

extensive collection of driver routines to customise it for use with a variety of different video adaptors, printers and plotters. There are drivers for some 15 different video adaptors – from Hercules and CGA through EGA to VGA and various 'special' types. Similarly there are 14 printer and plotter drivers, covering most common types of printer – from Epson MX/FX80 to HP Thinkjet and Laserjet, as well as a variety of popular plotters such as those from HP, Roland and Calcomp.

In short, like the PCB design packages Schematic is capable of working with a very wide range of standard hardware configurations.

In operation

Installing Schematic 3.3 on your system is very straightforward. It's simply a matter of creating directories for the program and schematic files, and then copying across the programs to the former directory from the master disks. The final step is typing in the name of your video adaptor, whereupon an appropriate batch file copies in the corresponding driver. Then you're ready to run.

The program you tend to use most of the time is *Schedit*, of course. This is the actual input and editing program, after all.

As with other schematic drawing packages, you build up a schematic with *Schedit* by calling up the component symbols you need from a library, giving them designations (R5, C17 etc) and values, and placing them in the desired positions. Then you link them according to the circuit, using connection lines and junction 'blobs'. Connectors, connections to ground and supply rails, coaxial cable symbols and so on are treated in very much the same way as normal component symbols – in fact as far as *Schedit* is concerned, there's virtually no difference.

Up to three component libraries can be opened at any one time, while you're building a schematic. In placing a component you're not restricted to its library orientation; you can easily rotate it in 90° steps, as desired. You can also 'flip' or mirror-image reverse it, in either the horizontal or vertical axes – very handy for things like transistors and op-amps. These functions are performed very quickly, using one or two keystrokes.

Placing a component, line, junction or text annotation using the mouse is very straightforward. You simply click the left mouse button to get the main menu; pull down the highlight bar to 'Place' and click again, causing the Place menu to appear; then pull down the highlight bar again to the appropriate item – Component, Line, Junction, Text or whatever.

If you're placing lines or junctions, this is all that is involved apart from using the mouse to locate the start and finish of each line or line segment, or the junction locations. With component placement there are further steps, where you select either the last type of component placed (offered by default – which can be handy), or select first a library and then the desired component from it. Then *Schedit* calls up the symbol, and prompts you for a designation and value, before finally letting you guide it in placing it on the screen schematic, in the desired position and with the desired orientation.

It's all rather simpler to do than this description might suggest, and somewhat faster. However once you get the hang of things you can speed them up even further, by using the keyboard 'shorthand' facility. This lets you bypass some of the menues, by simply typing letter sequences: 'PC' for placing a component, 'PL' for placing a line, 'PJ' for placing a component, and so on.

The same applies for the various schematic editing functions provided by *Schedit*. For example to delete a component, you can either click through the menues with the mouse, or simply type 'DC' – before indicating the component, of course! Similarly to move a

component you type 'MC', and so on.

As this suggests, there's a full range of entry and editing facilities. You also have a choice of line weights (4) and junction sizes, along with a choice of 10 different paper sheet sizes (A4 – A0, A – E) on which the schematic is to be drawn.

Nice features of *Schedit* include an Undelete facility, to reverse the last deletion in cases where it has been accidental; the ability to Zoom up and down, to check the overall look of a schematic as well as adjusting the fine details; the ability to customise the screen colours; a key macro facility, allowing you to program the function keys with frequently-used keystroke macros.

There's also an Options setting facility, allowing you to do things like enable/disable auto screen panning, adjust the time between *Schedit's* automatic file backups, turn the 'snap to grid' facility on or off, turn the sheet border and title block on or off, select the cursor shape and whether or not you want it to flash, and so on.

Another powerful and handy feature is a block manipulation facility, which allows you to 'define' a particular section of the schematic and perform various operations with it. These include moving it to another place, copying it, deleting it, deleting everything *except* it, or writing to disk. A block can also be read back from disk, and placed on the schematic – rather like a component.

Of course complete schematics can also easily be saved to disk, and recalled at any time to edit or expand them.

Having used *Schedit* to create your desired schematic as a disk file, the next step is to use *Schplot* to produce the corresponding 'hard copy' on paper.

Schplot employs the same system of pop-down menues, and is again very easy to use. Essentially you specify the schematic file you wish it to load, then specify the various print or plot options and parameters, and finally tell it to either print or plot.

Schplot includes a Setup mode, allowing you to do things like select custom screen menu colours, configure the serial ports, select a printer or plotter driver, and so on. In the case of plotters you can specify the number of pens, the plotting scale, the X and Y offsets (if any), the orientation, the port it's connected to, the pen speed and so on. There's a similar set of choices for printers.

Whether you're plotting or printing the schematic, during the actual operation *Schplot* displays a data screen showing progress. A nice feature, since the processing can take a few minutes with a reasonably complex schematic...

Incidentally, as with the PCB design packages *Schplot* can also plot or print to a disk file, rather than directly to a plotter or printer. This allows you to use plot file translation programs to further process the files, if desired. An example would be Insight Development Corp's 'PrintAPlot' program, which can take an HPGL plot file and print it out on a normal 9-pin dot matrix printer – with surprisingly good quality.

Schedit and *Schplot* are the two main programs in the Schematic package, and those that are normally used for most of the time. In fact if you don't use any esoteric devices and you're happy with the schematic symbols supplied in Schematic's various library files, you may well not need to use any of the other programs – unless perhaps you want to produce netlists for Autotrax, or Bills of Materials for manufacturing. I imagine this might apply for a significant proportion of Schematic users.

However at least some users will either want to modify some of the symbols in the supplied libraries, to suit their house style or personal preferences, or else need to create additional symbols for special components. It's for situations like these that Protel has supplied *SLM*, the 'Schematic Library Manager' program.

Earlier versions of Schematic used text-based files for each schematic symbol, and these were created and/or modified using a word processor or text editor program. However with version 3 Protel changed to a rather easier graphics-based file format, with its own graphics editor to allow symbol creation and editing directly on the screen: *SLM*.

Like *Schedit* and *Schplot*, *SLM* has a fully graphical user interface with pop-down menues and cursor control of symbol editing. However it also allows the original method of text-based file editing if desired, for those happier with it from earlier versions.

Schematic actually uses two different types of schematic symbol, the so-called 'Block' and 'Bitmap' types. The Block type is based on a simple rectangular box symbol, with the required number of terminal pins, as used by the majority of MSI and larger digital integrated circuits. In contrast the Bitmap type is used for most discrete components and analog IC's, which need a more elaborate basic symbol.

SLM allows creation and editing of both types of symbol. Using it you can either begin a new library, or call up an existing library, and either create new component symbols or edit existing symbols. You can also re-sort the components of a library you have edited, to bring them back into alphabetical order of names.

During editing, *SLM* lets you specify or change the size of the component, specify or change the number of connection pins, move the pins, specify or change the symbol bitmap as desired, and so on. And while you're creating or editing a bitmap, it makes things easier with functions to draw both straight lines and circles/arcs – as well as basic functions to allow plotting or deletion of individual pixels. There's also a 'fill' function, to speed up the creation of filled-in areas of the symbol.

Other facilities provided by *SLM* include the ability to base a new component's bitmap on that of an existing component bitmap, to add another component's bitmap into the bitmap of the symbol currently being edited, and to create multi-symbol components (such as the A, B, C and D parts of a quad op-amp device). In short, it's a very powerful tool for creating and editing component schematic symbols.

The remaining programs that make up the Schematic package are somewhat simpler in both function and operation, and have a text-interface format. As described in the Schematic user manual, they're much more in the nature of useful utilities, rather than primary programs.

In practice

Having now used the Schematic 3.3 programs fairly extensively over the last few months, we're hopefully in a reasonable position to give a verdict on both their ease of use and performance. And in general, I believe it's true to say that we're very impressed – with the package as a whole, and especially with the main programs *Schedit* and *Schplot*. These are both very easy and intuitive to drive, and make schematic creation, editing and printing/plotting surprisingly easy.

These two main programs in particular are basically fine, and Protel can be justly proud of their achievement.

Things we've found particularly nice about *Schedit* are the way it remembers the last component you've placed, and suggests this as a default if you go to place another – great for speedy placement of a number of common components; the way you can use both key-

stroke 'shorthand' and mouse control, for really fast operation; the way it lets you move components, lines and junctions readily; the way it lets you move component *labels*, relative to their symbol, to produce a tidier schematic; the degree of control it gives you over symbol orientation, as well as placement location; the way it automatically increments the default component designation, for repeated placements; and the way it also offers the last value as a default – very handy where you're placing a series of 100k resistors, or a gaggle of 0.1uF bypass caps.

Similarly *Schplot* has some nice features, including the way it remembers your preferred printer and plotter options, along with your screen colours and whether or not you like to print/plot the sheet border and/or title block; the way it allows you to specify the desired X and Y offsets; and the way it lets you set the number of plotter pens used, along with their speed.

We also like the way it will work with a wide variety of printers and plotters; so far we've been able to try it with two different 9-pin dot matrix printers, a Roland DXY-980A plotter and a Texas Instruments MicroLaser. We've also tried using *Schplot* to produce HPGL plot files on disk, and then getting IDC's *PrintAPlot* to convert them for printing on a dot-matrix printer. This is fairly slow, but certainly gives the best results if you only have a cheap 9-pin printer.

I have to say, though, that we have found a few things to grizzle about. One is that although *Schedit* does suggest the last component placed as a default, when you want to place again, it doesn't suggest the library from which it came as a default, if you indicate that you wish to place something else; instead you have to nominate one of the three active libraries all over again. It would speed things up a bit, if it offered the current library first – as this will often be the most likely choice.

Perhaps more serious is the fact that the printing/plotting resolution of *Schplot* is fixed at about 100dpi, especially for the bit-mapped component symbols. This means that some of these symbols plot or print out with clearly visible 'staircasing' of oblique lines and curves – even when you're using a plotter or 300dpi laser printer. This is a little disappointing when its sister PCB design package *Autotrax* will print out beautifully sharp and clean 300dpi artwork, if you have a suitable printer...

Another little gripe about the *Schedit* and *Schplot* combination is the limited

This is a bit of text in 10pt type
This is in 8pt type
This is in 16pt type
This is 20pt type

Here are the text fonts provided by the package. Frankly, we'd prefer a plain sans-serif font, like Helvetica...

choice of text fonts for component labels and text annotations. Basically there are only two, regardless of the type of printer or plotter you're using, and chosen purely on the basis of size. For the smallest of the four available sizes (8pt) you get a fairly ugly and hard to read sans-serif font rather like that found on cheap 8-pin dot matrix printers; for the other three sizes (10, 16 and 20pt) you get an even uglier and harder to read serif font.

Frankly in our view it would be better to have one clean and easy to read sans-serif font like Helvetica, in all sizes.

We found a few problems with *SLM*, too. The most obvious shortcoming is that it seems to do an excessive amount of 'disk thrashing' – accessing the hard disk much more than seems necessary. Frankly, it seems to load library files from the disk over and over again, apparently unable to remember that it already has them loaded into the memory workspace.

It loads the library you want to edit at the start of editing, and also immediately after saving it at the end of a session; then if you indicate straight away that you want to edit another symbol from the same library, it'll load it again! If you want to copy a symbol file from another library, it will load that too; but if you next want to copy another symbol from the same library, it'll load it all over again...

Somehow, *SLM* doesn't seem to keep the same track of its existing opened files, in the same way as is done by *Schedit* and *Schplot*. It also has a few little bugs still present, which mainly show up as a tendency to corrupt its 'bit map size' records, when you perform various symbol editing operations. This happened to us a number of times while we were trying to create an *'EA* style' symbol library, in some cases causing system crashes next time we tried to load one of the symbols which had become corrupted. Nasty!

A minor criticism of *SLM* is that when you're in bit-map editing mode and you call up the arc-drawing function to produce a circle or arc, it tells you to 'Select arc starting point'. In fact it's really asking for you to indicate the *centre* of the circle or arc's radii – a little misleading.

We contacted Protel Technology's software support manager Bruce Edwards about these shortcomings and problems, and he was very helpful. The company is very much aware of the 100dpi resolution limitation with *Schplot*, and is working on a new version which will provide full vector graphics as used in *Autotrax*. But unfortunately this is a fairly major revamp, and like so many pioneering Aussie firms they're not over-endowed with resources – so it may be a little while before the new version is ready.

Similarly they're aware that *SLM* still has a few flaky aspects, including its intermittent file corruption problems. The bugs responsible are proving extremely elusive to track down, but in the meantime they've found that a practical remedy is to force *SLM* to re-save the currently open library after editing each symbol – rather than editing a number of them before saving.

In the meantime they've decided to do a complete revamp of the symbol editing routines, and possibly build them directly into *Schedit*.

Summarising

On the whole, we're very impressed with the Schematic 3.3 package. It's a very practical and easy to use CAD package for drawing circuit schematics, using reasonably-priced MS-DOS PC's. And it gives very professional-looking results, at a price ($995) that compares well with others that are available.

The fact that it still has a few little shortcomings is basically disappointing only because the package as a whole is of such a high standard. If the folks at Protel can fix them for the *next* version of Schematic, they're going to have a really outstanding world-class package.

When this happens, I certainly hope they give us the opportunity to try it out. In the meantime, I'm proposing to keep using version 3.3 – despite its blemishes. So don't be surprised to see a few 'Schematic schematics' in the magazine...

Like the other Protel CAD packages, Schematic 3.3 is available through many software dealers and CAD specialists. However if you have any difficulties in tracking down your nearest dealer, Protel Technology is at Technopark Dowsing Point, Hobart 7010 (GPO Box 204, Hobart 7001) or phone (002) 73 0100.

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The Fluke 45 is a true-rms meter, with 0.02% basic dc voltage accuracy and 100,000 count resolution on both displays. Basic dc current accuracy is 0.05%, making the 45 ideal for servicing 4-20 mA current loops. Closed-case calibration simplifies the calibration process and increases uptime.

Even an RS-232 interface is standard.

Connecting the Fluke 45 to PCs, RS-232 printers and modems is as easy as attaching the cable. An IEEE-488.2 interface and rechargeable batteries are available as options.

Get everything you've ever wanted.

For all the information on the new Fluke 45, contact your local distributor.

FLUKE 45 DUAL DISPLAY MULTIMETER

Dual Display	Compare and Relative functions
True-rms voltage and current, including ac + dc	Min Max and Touch Hold® functions
0.02% basic dc voltage accuracy	Optional PC software for RS-232 applications
0.05% basic dc current accuracy	Optional IEEE-488.2 interface, battery pack
1 MHz frequency counter	One year warranty
RS-232 interface standard	
dB, with 21 reference impedances, and audio power calculations	

READER INFO No. 46

For Further Information Contact Your Local Philips Test & Measurement Organisation: Sydney (02) 888 0416, Brisbane (07) 844 0191, Melbourne (03) 881 3666, Adelaide (08) 348 2888, Perth (09) 277 4199, Auckland (09) 39 4160, Wellington (04) 88 9788.